Cognitive factors behind second language acquisition – presentation of new candidates

Supervisor: Zsuzsanna VAJDA, Marianne NIKOLOV

Abstract:

The thesis tries to link results from two streams of cognitive psychology: one being general cognitive mechanisms behind language learning and the other individual differences. It also presents data concerning how old ideas based on cognitive aptitudes can be broadened with newly emerged ideas in the field of cognitive science. There are three issues that are going to be addressed in detail, the first one being theory of mind and its development, the second implicit cognition and finally a much debated issue, memory inhibition is also discussed as an underlying possibility to enhance success at language learning.

Theory of mind is a debated issue in itself, however its relationship with empathy and emotional synchronization are even more debated. It has been suggested to be in relation, yet it rarely appears as a factor of a good indicator of language learning ability. Its relevance in language learning is probably underestimated, based on basically two reasons, one could be related to „quality of input” reason and the other to the „quantity of input”. The first, quality of reason explanation would suggest that a better ability of reading the others’ mind – be it an emotion or cognition based reading – permits the decoding of more complex messages based on non-verbal cues, thus from the supposed intent the message itself becomes clearer. Therefore the same input can become more comprehensible and therefore better understood. The quantity argument is based on the fact that a good theory of mind can keep communication alive for longer, thus eliciting more input from other speakers – leading to more possibilities of practice. The relationship has been proven using the Reading the Mind in the Eyes test, a test that is supposed to measure both the cognitive and the emotional factors of theory of mind. (publications 4, 5, 6 – see below)

The term implicit cognition has emerged in cognitive science various years ago, and the idea has infiltrated into Second Language Acquisition (SLA) theories rather quickly. However few experimental studies have been done in order to examine the role of the ability of implicit learning in the ability to acquire a second language. The experimental design used measured implicit memory with two tests and gathered data about the linguistic knowledge of college students. The results show that implicit learning helps to acquire the grammar and it is also useful in acquiring native-like production. (publications 1,2,3)

Inhibition has been proposed to be an important part of memory functions in bilingualism, as in order to be able to used a different lexicon from ones own, it is essential that one be able to suppress native words that are automatically retrieved. Therefore the hypothesis is that people with higher inhibition rates – as measured by the Stroop test – have a better chance to use their foreign vocabulary, especially under time pressure.

The conclusion of the thesis is that newly emerged factors in cognitive psychology are not irrelevant to the practical issues of language learning and language teaching. Although two of the three measures described in the thesis (implicit learning rate and ability of inhibition) are supposed to be impervious to development, it is proposed that different teaching methods of differentiated exercises in language teaching can facilitate the learning process.
1. Psychological research on individual differences

There are striking differences between learning one’s first language and subsequent languages, acquired later in life, differences so outstanding that it has begun to form an integral part of folk psychology: fluency of production, awareness of metalinguistic knowledge, effort of acquisition and finally the interest of the current work: individual differences. Individual differences are very interesting from the point of view of cognitive psychology, considering the continuous strain to establish an overarching universal model to human cognition. Individual differences are generally swept off to the terrain of personality psychology, even when dealing about intelligence, a markedly cognitive ability. This thesis is trying to form a connection between the two traditions in psychology, namely universality and individual differences.

Segalovitz formulated the question as follows:

„Why do individuals differ so much in second language attainment success? After all, every healthy human being in an intact social environment masters a first language to a degree of fluency that, in other skill domains, would be recognized as elite or near elite levels...“

(quote: Segalowitz, 1997, p. 85)
2. **Pragmatics in language learning**

Compared to other areas of linguistics, the teaching of pragmatics of a given language is underrepresented in most school curricula, in spite of communication being the whole point of language learning and teaching. The importance of pragmatic skills and the skills to communicate can be underlined by the fact that as of date the Hungarian Language Examination Board (Állami Nylevvizsga Bizottság) concedes 25 points out of a maximum of 70 for communicative value, which can easily be understood to be related to the correct use of vocabulary, grammar and idioms, however it depends on the ability to transfer information comprehensibly from the speaker to the listener, which is at least partly tied to pragmatic skills. This would assume an aptness and good ability to communicate would greatly contribute to the success at language exams and it is definitely a value when communicating with foreigners.

The basic assumption of the relationship between theory of mind and SLA abilities relies on this connection with pragmatics, based on the theory of relevance by Deirdre Wilson and Dan Sperber, reformulated in (1987). Their proposition is that the principle of relevance is based on a specific functioning that they named “pragmatic inference”, which in their interpretation is a metapsychological ability, therefore it is not just a general psychological mechanism – such as general problem solving or mindreading – expressed in language, but a specific mechanism of with distinctive mechanisms and independent functioning. They digress from the traditional view of language that describes linguistic communication as the transmission, coding and decoding of information and propose that understanding is based on implicit inferences that are drawn on the basis of the cues provided by the speaker. Relevance of an information is regarded as an interaction between the amount of new information that can be extracted with the least amount of effort that is needed to convey it, in the words of the formulators of the theory “the largest cognitive effect for the smallest possible effort” (1987, p. 698). In their view people are equipped in communicative situations with the presumption of relevance, that is they suppose that the linguistic cues provided by the speaker are relevant enough to be worth processing and that the speaker will try to convey his intended information in the most economical way possible. All the information from the input (be it visual or auditory) is combined with information in the Central Systems, which forms hypothesis on the basis of this combination. The formed hypothesis are fed to a Deductive Device, which is used to confirm, deny or modify the assumptions made earlier. Sperber and Wilson argue, that the Deductive Device works by making deductions and thus the entire system of pragmatics rests on non-demonstrative inferencing (Luchjenbroers, 1989). Non-demonstrative inferencing is different from demonstrative deductions because the truth of the premises merely make the truth conclusions probable as opposed to deductive reasoning where the truth of the premises guarantees the truth of the conclusions. The obvious attractiveness of assuming deductive processes is that it would provide an accurate and relatively reliable tool to provide conclusions if one initially possesses accurate premises. The conception of the Deductive Device as a logical automaton that churns out assumptions based on reading memory, reading and rewriting logical forms and storing the resulting assumptions might be alluring, yet it is psychologically rather dubious.

Sperber and Wilson further assume that this ability to make inferences has co-evolved with that of language (Sperber, 2000) each supporting the other. As we shall elaborate later, there is evidence that language development in most cases runs in parallel with some measures of pragmatic development, such as understanding metaphors. Even though in their interpretation of pragmatic inferences the authors describe this as an independent mechanism, nevertheless when they dissect it into different sub-mechanisms, one finds that there are two sub-components that are difficult to distinguish from the construct of theory of mind and
perspective taking in psychology (Sperber, 2002). Particularly, 1. and 2. (see table below) are
difficult to distinguish from a psychologist’s point of view, as metapsychology is understood
as theory of mind and comprehension is understood as a type of cognitive perspective taking,
arguably both needed to be able to solve classical theory of mind tasks, such as the Sally-
Anne task, or the Three Mountain Task (to be described later).

<table>
<thead>
<tr>
<th>Module</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Metapsychology</td>
<td>Theory of mind: attributing thoughts and intentions</td>
</tr>
<tr>
<td>2. Comprehension</td>
<td>Understanding the speaker’s point of view</td>
</tr>
<tr>
<td>3. Logic</td>
<td>Coherence of the argument or line of thought</td>
</tr>
</tbody>
</table>

Sperber’s (2003) theory of pragmatics as a modular system of several layers. The ordering is arbitrary.

Although the tasks that tap Theory of Mind and Perspective Taking in psychological
experiments expect solutions that are available using deductive reasoning solely (assuming
that one possesses the assumption that minds are independent and can hold mental
representations that are different from each other based on the available information) there are
clear cases in psychological research where deductive ability is not in line with performance
on theory of mind tasks, the most frequently cited case being autism (Baron-Cohen, 2002).
The proposal of the thesis is that in fact, a module that is in service of understanding others –
by whatever name we may call it – is not only influential in making sense of others point of
view and essential in first language learning, but it is also crucial in Second Language
Acquisition. The difficulty in trying to show a relationship between second language
acquisition data and theory of mind or perspective taking measures lies in the lack of adequate
tests for the measurement of individual differences in adulthood in theory of mind or
perspective taking. The evidence I shall present is based on a newly developed test by Simon
Baron-Cohen (2002) as it is one of the few tests to measure individual differences in adult
population in an ability that he calls theory of mind, however as we shall discuss later, the
interpretation of his results can also allow for other explanatory frames. However the initial
hypothesis was that these differences are indeed based on theory of mind ability or on the
broader concept of empathizing ability.

Gender differences

2.1. Systemizing and empathizing as a new dimension in gender differences

The importance of the two types of stances proposed by Dennett (1998) have been
reformulated by Baron-Cohen (2003) (though he himself does not relate these stances to the
work of Dennett), who intends to use it as an ultimate explanation for the difference between
men and women and derives it from his work on autistic spectrum population. Baron-Cohen
claims that so far most studies on differences between men and within emphasize the
distinctive feature of spatial and verbal abilities (Baron-Cohen, 2002), however he proposes
another explanation. He presupposes two kinds of possibilities in interpreting the world,
which he terms as systemizing and empathizing. The difference between the sexes is not
predetermined completely though, as he himself underlines it, most often men have “male
brains” and women have “female brains” (hence the nomenclature), yet though typical as the
brain functioning can be of the sexes, it is not a clear-cut separation line. As a matter of fact
Baron-Cohen (2003) elaborates on the different senses of sex, making a distinction between
 genetic sex, gonadal sex, genital sex, brain-type sex and sex-typical behaviour. Biological sex
is determined genetically and among the homo sapiens an XX chromosome pair is a female trait, while males are in possession of an XY pair of chromosomes. Gonadal sex in turn is dependent on the hormone-producing sexually different organs that are expressed (a testes in typically developing males and ovaries in case of females), which are most often (but not exclusively) in accordance with biological sex. The few examples mentioned are Androgen Insensitivity (AI) Syndrome and Idiopathic hypogonadotrophic hypogonadism (IHH) which both render males a more female-type brain (see below for further explanation). Genital sex however refers to the sexual organs that an individual possesses, that is a penis in case of males and a vagina in case of typically developing females. As to brain type, he describes this making use of his own theory, claiming that a male brain is more inclined to systemizing, while a female brain has a tendency to empathize with others. It is clear from his description therefore, that the characteristics he hypotheses follow directly from differences in brain organization and are determined biologically via a cascade mechanism that is set off by genetic differences. Sex-typical behaviour in his view follows directly from the brain type of the individual and makes men prefer gadgets, collections and football leagues over caring for friends and worrying about their feelings, which follows from an empathy-wired brain. In his view, autistic spectrum disorder is none less than an extreme male brain functioning, with overproportionate systemizing skills. Although Baron-Cohen (2002) is very careful about making value-based judgements on the differences between the two sexes, in his account it is to be assumed that systemizing is only associated with skills that are traditionally categorized under cold cognition, while empathizing skills generally pertain to a category that would be labelled either hot cognition or affective cognition. Although most differences he describes between the sexes are highly accurate, these often emanate the feeling of being rather loosely chained co-occurences than traits, a case rather clear in the case of aggression, which fits perfectly into the picture of the differences between men and women, but it is difficult to argue that it should be strictly based on input-output patterns, although its incompatibility with empathy is intuitive (while not in a strict sense necessary: one can be aggressive and suffer from his or her own aggression because of empathy). Although Baron-Cohen (2003) stresses the importance of biological explanations there is an interesting study, that indicates that though biological foundations might exist, there is a very strong pressure by society to behave in line with expected sex roles. Nakayama et al. (2007) found a strong relationship between cortisol levels and sex-atypical behaviour, thus high levels of cortisol among S-type females and E-type males. Cortisol is a corticosteroid hormone that is produced in the adrenal glands and it is often referred to as the stress hormone as it is one of the major elements in a cascade mechanism related to stress (????).

2.2. Systemizing and Empathizing as Personality traits

Baron-Cohen builds an entire structure of personality around the concepts of systemizing and empathising that he declares to be fundamental. He posits that these two explanations for the world are blended in most people in different amounts. Therefore he describes five personality types, depending on the amount of systemizing or empathizing that is present in their thinking. He uses mathematical relation signs for shorthand for his typology. Women are most likely to pertain to the E>S category, which defines people who are better at emphasising than at systemising and this is what he basically designates the term “female brain” to. On the other hand most men are likely to be members of the group S>E, being better at systemizing than at emphasising, thus earning themselves the title of a “male brain” possessing group. Baron-Cohen posits a group that has emphasising skills that are equally
developed as their systemising skills, who are designated by E=S. The other two groups are formed by those who are extreme outliers of either one of the cases, thus E>>S are a group of people who are extremely talented empathisers but in turn they are at loss when explaining systems, while S>>E are people who – according to Baron-Cohen – are generally diagnosed with Autistic Spectrum disorders in today’s society. Baron-Cohen goes to all length in drawing emphasis on the fact that his theory does not state that all women have a female brain or that all men are inevitably proprietors of a male brain, instead he is convinced that these are more of tendencies than deterministic categories.

There is a controversy in his theory however, when it comes to evolutionary explanations. He enumerates the advantages and disadvantages of both empathising and systemizing and then adds that the two are basically zero-sum games, therefore the more one has of one the less room the other has for development, yet stating that people who are highly proficient on both exist. Before considering this controversy, let us look more closely at what he considers evolutionary advantages and setbacks in systemizing and in empathizing. The description of these traits is largely based on Baron Cohen’s book entitled “The Essential Difference: The Truth about the Male and Female Brain” (2003).

3. Systemizing

Systemizing events in the world consists in finding exact rules to them that can be predicted from events seen by any third-party viewer as well. By systems Baron-Cohen means “anything that takes inputs and delivers outputs” (Baron-Cohen, 2002; p. 248), therefore various examples are possible, yet the best examples always given by mechanics, but anything that can be described by IF-THEN rules can serve as an example, anything that is governed by definable rules between its input and output variables. He cites various examples, such as physics, maths, military strategies, the climate, board games and even sports, not failing to mention legal and political systems either. Systems are supposed to have a finite number of states and by varying their characteristics one by one, the functioning of the system can (in theory) be fully described.

He posits six kinds of different systems. Technical systems can only be found in modern society as they are mostly the result of the technological advancement since the industrial revolution, such as computers and machines. However, more rudimentary tools are mentioned as well, such as hammers and musical instruments. Though it may strike one to hear that a hammer is something that can be systemized, there are clearly differences in the power and use of hammers for example varying the length of their handle or the size of their head, which makes them liable to IF-THEN rules, and therefore they are systems. Natural systems are more ancient as they are the IF-THEN rules governed entities created by mother nature, such as plants, the weather or the movement of the planets. These systems are later hypothesised to be at the heart of the evolution of the ability to systemize as Baron-Cohen posits that understanding and most of all controlling the forces of nature was among the most powerful candidates for the evolution of the systemizing brain. Abstract systems are those that have no tangible sources, and are probably themselves derivations of natural systems, the most prominent members of this group being mathematics or syntax. Social systems in turn have been created by society in order to organize the social interchanges and functions in ever growing societies. While dominance hierarchies can be observed among many species, the homo sapiens has gone a long way into specializing in different directions and creating various particular functions in their groups. This led to such social systems as are political election systems and legal systems. Organisable systems are understood mainly as a categorizing tool for a mass of objects or concepts, such as taxonomies and library catalogues.
The main motive for the inclusion of this category is probably the often occurring habit among children and adults living with personality disorders to amass a number of items from a category (which can be trading card game items of music numbers) and categorize, label and organize them so that they are easily identifiable and perfectly ordered. The last category motor systems is perhaps the most surprising of all in Baron-Cohen’s theory as it departs from largely cognitive brain functions and abstract notions, as well as consciousness. While the examples mentioned above are all conscious and well-reflected areas of thought, motor systems are definitely part of an implicit system. This means that systemizing is an overarching organizing principle for all areas and its scope is not limited to consciousness or explicit memory. Systemizing is generally an inductive process that consists of meticulous examination of the situations at hand and deriving rule-based regularities. The laws that are distilled to govern the system are finite and deterministic, yet they can be refuted in light of contradictory evidence in which case an alternative rule has to be established. The question invariably arises though why systemizing can not be used with human beings. The answer is generally that systemizing requires observable and finite states of affairs and the human soul and the resulting behaviour fails to fulfil both by far. This results in the frustrated confusion that people living with autistic disorder feel when approaching humans, as they form a system that they are incapable to determine the rules of.

As a consequence, language is a system as well (or to be more precise various systems, as most descriptive linguists would be adamant on the different rules that govern each idiosyncratic dialect). However, even if there is disagreement about what the rules in languages exactly are, there is a general agreement; the rules that govern linguistic functioning do exist. Language can be assumed to have various subsystems, for examples syntax, phonetics or morphology, even though Baron-Cohen usually only mentions syntax. There is one aspect of language however that is particularly impenetrable for a systemizing approach, which is pragmatics, or in other words grasping the meaning behind the actual semantic content that is delivered in speech. Although there have been various attempts at creating a system and rule-based approach to pragmatics, one of them benchmarked by the name of Searle himself in his theory of speech acts (1969, earlier put forward by Austin, 1975), these seem to fail to give a complete account of language-based human interactions. The advantage of systemizing in a second language learning environment becomes evident in taking into account the heavily rule-laden teaching style that prevails in most classrooms even in spite of the spread of communicative teaching methods. However, there is a problem with this explanation that must not be left unaddressed, as Baron-Cohen states that learning these rules is very much like what behaviourists called associationism, with the exception that in this case there is no reward involved, or rather the reward is much more of an internal kind, deriving joy from the discovery of the world in itself, satisfying an exploratory drive. However, language can not be explained by associationistic rules in its totality, as Chomsky (1968) himself has pointed out in his critique of Skinner’s „Verbal behaviour” (1957). As Chomsky’s point of view seems to have been verified by subsequent research, there are two explanations to resort to. The first would be to extend the notions of general rules learning in the work of Baron-Cohen and others further than simple association learning. The other would be supposing that knowledge of a second language is per se inadequate for this same reason, as languages can not be dealt with using such a mechanism entirely and thus calling on some explanation based on sensitive periods in language learning. Baron-Cohen supposes another difference, which consists in systemizing being uniquely human as opposed to association learning which can be found universally across all species. However, the reason for this difference is not fully explained. We shall elaborate on systemizing as a potential candidate and rule-learning in a subsequent section dedicated to rule-learning and statistical learning and will posit a new candidate therefore to the types of systems.
3.1. The evolution of systemizing

Systemizing has the distinct advantage of not only understanding nature, but also to control it. Using and making tools for example was a major step towards the success of the *homo sapiens* in the history of evolution. Lacking speed, extreme power or sharp teeth and claws, which have long since been “invented” and used by other species, the human race depends extensively on an artificial world that surrounds it and which it creates itself as an exceptional niche. Tool making and use both require systemizing as it is essential to see the physics of the tools in advance, and to be able to predict which characteristics must be used in order to improve them. The history of science seems to have backed up this claim by Baron-Cohen as most technical inventions are work of men. Baron-Cohen stresses the special case of weapon forgery which is overtaken in most societies by men even if physical force needed to wield the metal is not a primary motivation for this. It can be argued however that this is rather a side-effect of the fact that it is men – being the more aggressive of the sexes – who use these weapons and therefore they are keen on creating and developing them.

Hunting and tracking are almost exclusively pursued by men in all societies with women rarely participating more in the act than preparing the meat for consumption. Baron-Cohen lines up a range of explanations to account for this phenomenon, starting from the need for keen observation, across spatial navigation up to the ability to understand and predict weather and the forces of nature that are essential to survive. Another example observed is trading, which requires the use of exact calculations on the worth of goods and a keen mind to discover rules governing a market. There is a curious divergence in the theory of Baron-Cohen at this point as he observes that in order to be a good trader some need of empathising is needed, in order to predict what other traders and consumers would respond to certain flows of the market or in order to keep information from other traders should that be more lucrative in a game theoretical sense. However, while this cognitive component of what he terms empathising is an imperative, the emotional side would be a considerable setback in a similar situation, as anybody who tries to be a good trader and is highly concerned with the losses of others is not likely to become very rich. Even though Baron-Cohen remains adamant on the inevitable alloy of affective and cognitive components in empathising, he is clearly at loss in explaining some aspects of their clear separation (the other obvious example being the case of psychopathy).

Social systems being just like other systems, according to Baron-Cohen (2003) recognizing their functioning contributes to a successful rise in social rank. Monitoring one’s rank in the hierarchy is likewise supported by systemizing. Here another controversy arises as Baron-Cohen calls on politics to explain rises and falls in social rank, however politics depends arguably on reading the minds of others, at least in modern societies. Being a good politician definitely involves getting the support of your fellow men, and this means being able to predict human beings. According to Baron-Cohen’s theory the realization that certain actions lead to a move upward or downward in hierarchy makes good politicians, but it can be easily contested whether politics is as easy to predict as that. On the other hand one might argue that male-brained individuals might behave in a more rule-based manner and can thus be “computed”, however this would contradict another claim of the author that is based on the fact that women can thwart aggression by being able to predict their more aggressive partners next move. Nevertheless his argument based on sexual selection, stating that men higher in social hierarchy are more attractive to women – a fact proven various times in anthropology – because independent males who have a good understanding of social principles seems to be convincing, though still not reliably dependent on systemizing. This is basically the same as his alpha-male argument that supposes that women choose their partner based on social rank and therefore it is vital for men to be high in the social hierarchy. Men with higher status are
indeed proven to have more descendants even in modern societies, not to mention ones that allow polygamy for men. This assumption is supported by the fact that while men seem to score lower on tests testing emotion recognition, they are superior in detecting threat, which is an essential part of maintaining and gaining social rank.

Higher aggression level is not directly a consequence of systemizing, but rather a lack of empathy, which is a co-effect of high systemizing. Wars tend to be fought by men in most societies, though the relationship is not clear between physical strength, aggression and sex. While it is obvious why a more aggressive individual would need more strength, there is no straightforward reason to support why one sex should be superior to another in this aspect, unless we suppose an aggression gauge that is both well supported empirically and follows logically. The higher the level of aggression, the more outbursts it induces and the more difficult it is to keep a rein on it. A sex that has been allotted with the task of primary childcare is more than likely to be less successful if the aggression level reaches too high.

What as today we term as research and development is many times a solitary attitude, which is much more easy to tolerate if the person in question isn’t badly in need of company for most of the time, in other words does not need to socialize that much. As empathy is a leading force towards other people, towards caring about them, it is unlikely to help in bringing about any major breakthrough in technology as this might take weeks, days or even months to accomplish, many times in a far-away place in complete solitude with no one to socialize with. This would inevitably lead more men to pursue this path and less women to follow them.

Aggression has long been proven to be more characteristic of the male sex, yet the first evolutionary argument Baron-Cohen states is not that of group defence that is most likely to occur in other sources (e.g. Gaulin & McBurney, 2000) but that of intimidating partners and controlling their sexual behaviour, thus ensuring that offspring share the genetic codes of the partner male. Aggression as mentioned before does not bear a tight bond with systemizing yet it clearly demonstrates the lack of empathizing. Aggressive behaviour in men can lead to a rise in the social rank as in pre-industrial societies it has often been observed to be the case, increasingly so because most aggressive actions take place in order to defend the reputation of oneself and thus if successful it can lead to a direct reinforcement of social status. Betzig (1997) remarks that aggression and other expression of power was highly related to the number of offspring in a variety of societies, Mezopotamian, Chinese, Aztec, Inca alike. As the rulers she describes were not only known for their polygamy and their harems and numerous children, but also of their cruelty, it can be concluded that some level of aggression at least can aid in being successful. Leadership in a group might also be an important factor in rewarding systemizing, in a way that in work and organizational psychology one would find described as a results-oriented leadership style. In essence the view that places goals above people can be successful in situations where there is time pressure or the success of the task is a question of life or death, such as in case of wars and campaigns. In modern society insensitivity to certain human problems would lead to better results for example via exchanging ineffective – though socially maybe disadvantaged – workforce with more adept people. Though modern science may be only a few centuries old, folk science has probably started at the dawn of human evolution and it would certainly not be able to survive without systemizing skills.

3.2. Evidence for superior systemizing in men

As Baron-Cohen considers all rule-governed behaviour evidence for systemizing skills, the evidence he presents for superior systemizing is diverse. Some examples, such as chess and football as rule governed systems are straightforward, others such as role-playing games are
less conspicuous, while it is acceptable that conversational skills are probably not entirely rule
governed, unless we accept relevance theory without criticism. As anything that can be
described with a set of rules describing the relationship between input and output, there are
various lines of evidence that prove that men excel at systemizing skills. There are exact
calculations about the systemizing brain: according to Goldenfeld et al. (2006) men have a
44% chance of developing a systemized brain, while only 14% of probability exists for
women in the same dimension.

3.2.1. Systemizing games such as chess
Although the difference is undeniable and striking in the case of chess, which is being most
heavily studied by cognitive psychologists, as only 1% of the world’s grandmasters are
women (Chabris et al, 2005). The argument of Chabris et al. (2005) is based on discrimination
rather than on ability, as they claim that more boys enter chess competitions at the lowest age
possible and they report that drop-out rates are constant and there is no difference between the
sexes. He also observes that in playing communities, where an initial ratio of 1:1 is
established between girls and boys, there is no difference between the ranking of the sexes.
Howard (2005) however argues that the differences seen in men and women between chess
results from two sources, one of them being general intelligence and the other one visuo-
spatial abilities. His argument relies on the recent change in the age of grandmasters, with
youngsters entering professional chess at the tender age of 12, but the decrease does not seem
to be running parallel in men and in women. As younger females have better visuo-spatial
ability according to Howard (2005), one could expect a deeper decline in age, than in the case
of men. However, this is not the case, there is a tendency of a decline in age to enter master
level, but there is much more noise in the data, with the average age actually increasing
slightly between 1980-1990, a phenomenon not observed in the case of men.

3.2.2. Engineering, mathematics, mechanics and physics
According to Baron-Cohen (2003) boys tend to prefer toys that can be categorized as open to
being “systemised” such as vehicles, mechanical toys and building blocks. Later they prefer to
choose occupations that are related to systemizing to break apart from the basic example of
engineering, physicist and mathematician. According to Baron-Cohen (2003) the ratio of men
and women working in the field of mathematics, physics and engineering was about 9:1 and
he suggests that the difference is not much greater today. There have been repeated
suggestions that this is due to the fact that these fields are rather disencouraging for women,
but the ratio does not change much across cultures and there is a marked difference between
different fields of science, biology presenting the highest number of women (around 23 %)
while physics and engineering moving around 3-5% according to a national survey conducted
by the National Science Foundation in the United States (cited by Baron-Cohen, 2003). Repeated accusation on behalf of feminists have criticize these sciences to be biased towards
male students and accepting them more often, than females. While sexism is unlikely to
operate in consciously in the United States, unconscious attitudes might explain some part of
the data, although proof would be very difficult, as by definition interviewers would be
unaware of it. Baron-Cohen (2003) argues that it is in fact a side effect of engineering
students’s selection based on mathematical ability tests, which would be a well-founded
discrimination as both engineering and physics depends heavily on mathematical abilities.
According to Gallagher et al (2000) males get higher points on the SAT-M tests (a
mathematical subtest of university entrance exams on the subject of mathematics in the
United states), because they are better at matching algorithms to problems in both
conventional and non-conventional tests in mathematics, even though some earlier research (Gallagher & de Lisi, 1993) found that in conventional problem solving women outperformed men. In problems requiring insight, men were indicated to be superior to women (Gallagher et al. 2000). Another test applied at college level, the GRE-Q (Graduate Record Examination – Quantitative) is declared to show the superiority of male students as well (cited by Gallagher et al. 2000). According to Baron-Cohen, on the SAT-M males score 50 points higher than females. The difference becomes even greater among high achievers, above 700 points the ratio of men to women is 13:1 (Geary, 1996). Mathematical abilities moreover seem to be highly determined by genetics according to a research on 7 year-old-twins (Kovas et al. 2005), while reading and general intelligence is also posited to be dependent on the same genetical variables, thus justifying the “generalist genes” hypothesis put forward in intelligence research.

Other often preferred job by males are manufacturing-based jobs, such as musical instrument manufacture, weapon making or metalworking (although it has to be underlined that when the necessity of physical force is not a must in metalworking jobs and the target object is more feminine, women become much more prevalent, such as in the industry of jewel-making).

3.3. Differences in general intelligence factors - a bias for systemizing?

Although Simon Baron-Cohen avoids carefully all traps of politically incorrect formation of his theory, some researchers have interpreted his results (Jackson & Rushton, 2006) in a way that would equate systemizing (which however they erroneously term synthesising in their article) and general intelligence or g, therefore positing that men (instead of being better systemizers) are more intelligent on the whole. This might shed a new perspective on the interpretation of systemizing and empathizing as well, although probably only revealing biases and value judgements about systemizing in society, that I shall try my best to neutralize.

The resolution of this conflict between systemizing and intelligence obviously depends on the exact definition of what we mean by intelligence and intelligent behaviour, given that systemizing has a relatively good definition. Although the definition of intelligence in itself is a controversial issue, with definitions as vague as “the ability to process information” (Fagan, 2000) research has shown that indeed educators often consider intelligence the speed of knowledge acquisition, knowledge construction and modification (Braten et al. 2004), which would favour systemizing abilities overall, thus creating a disadvantage for women. Baron-Cohen is not always clear throughout his book on the exact sense of intelligence, he finds it important to emphasize that “Overall intelligence is not better in one sex or the other, but the profiles (reflecting relative strengths in specific domains) are different between the two sexes.” (Baron-Cohen, 2003, p. 10). However, when talking later about Konrad Lorenz, whose idea of ethnic purification indeed left little space for an empathic interpretation, he can be understood to use the term intelligence to denote his systemizing skills. When speaking about autistic spectrum he also concludes (when talking about calendar calculations and islets of ability) that they are very intelligent in certain tasks, but “this is clearly another kind of intelligence”(Baron-Cohen, 2003, p. 135.) Still later he concludes that is no relationship between traditionally measured IQ and systemizing, as autistic children are highly systemizing but are often find in impaired categories of intelligence scores. Systemizing skills by definition seem to load directly on intelligence scores (understanding systems – for example RAVEN test is a classical system based test), whereas empathising skills rarely do so directly. Supposing that although empathizing skills themselves do not enter directly into intelligence scores, the results of the empathizing system – namely good verbal skills and
better verbal memory – might be determining factors. The equality in this case would then be a question of the ratios difference tasks enter into the titration in creating intelligence test. Jackson&Rushton (2006) even go as far as predicting a general difference in $g$, a general factor of intelligence originally proposed by Spearman (1904, cited by Jensen, 1998). Although for centuries a consensus about the lack of sex differences in general intelligence has been upheld, some researchers are now debating the issue. Originally the conclusion that sex differences don’t exist has been put forward by British psychologist Cyrill Burt, who based his results on the performance of secondary school boys and girls to whom he administered a serious of reasoning tasks (Burt&More, 1904, as cited by Jackson&Rushton, 2006).

Indeed relying heavily on the distinct pattern of high and low performance areas that are characteristic of the sexes, general intelligence tests are often constructed to produce an overall score that no longer presents a difference between the scores of the sexes (Jackson&Rushton, 2006). The areas in which males seem to excel are areas of spatial ability and mathematical reasoning, while girls seem to be better in some tests of memory and in verbal intelligence as well as fine motor coordination within the body space (Kimura, 1999) (though this latter rarely ever appears in intelligence tests). All these data fit well into the systemizing-empathizing theory proposed by Baron-Cohen (2003).

Research presenting no sex difference between males and females has repeatedly presented with various test batteries and different standardization samples (Jackson&Rushton, 2006). Jackson&Rushton (2006) however found that women scored lower on both verbal and mathematical subtests of SAT, which is somewhat surprising in the light of previous research. They further argue that there is a general $g$ factor underlying both SAT-M (mathematical) and SAT-V (verbal) subparts of the test as after a principal component analysis the calculated $g$ factors have a congruence of 0.90, therefore one can safely assume the two do not form two different factors, but a single one, thereby blurring the line between the areas that traditionally mark the difference in performance of the sexes. It has to be noted however, that the number of factors usually depends on the strictness applied when looking at the factor loads, this in itself is not surprising, since correlating data can often be reduced to a single factor. Nevertheless when reduced to this single factor, they argued that women had lower points on $g$ than men, taken SAT-M and SAT-V scores into account. The dissociation assumed by Baron-Cohen are not very clear in this case, but then again the results are not based on standard intelligence tests, but SAT tests (although this argument is hardly convincing for two reasons: first of all, SAT scores are reported to be correlated with results on different intelligence tests and secondly because SAT tests are also calibrated to be insensitive to sex, ethnicity or socioeconomic status, nevertheless Jackson&Rushton (2006) present on a large sample that there are large differences in all these aspects). This suggests that the test has not been as well balanced as it is supposed to have been.

The delicate issue of sex differences is further aggravated by research on the relationship that has been established between the size of the brain and general intelligence scores. Davidson Ankey (as reported by Jackson&Rushton (2006)) has re-analyzed the data on the weight of brains at autopsy and concluded that even after correcting for body size, males still averaged a larger brain size than females did (a difference of 140 gramms before adjustment and 100 gramms after adjustment). Rushton (1992) replicated the data using measurements of cranial size and other body size measures and the difference has also been shown using MRI techniques as well, concluding finally that men have on average 15% more neurons than women. Moreover there is a vast body of research that supports the relationship between brain size and general intelligence, which amounts to a correlation of around 0.4 (as cited by Jackson&Rushton, 2006). This would inevitably entail the fact that men indeed have higher general intelligence than women.
It can be concluded therefore that research on intelligence generally supports the theory of empathizing-systemizing by Baron-Cohen (2003) as it either presents equal intelligence with higher verbal abilities in females or higher intelligence for males using tests where tasks considered part of systemizing skills are used more extensively. It is important to peel of social judgements residing in society today about intelligence, which is probably the most venerated characteristic in today’s industrial society. This should be hardly surprising, as success in life and rise in society are both dependent on this factor (and the same could be said about systemizing). On the other hand importance of empathy is often neglected in society, as it produces less visible results and further denigrated by a considerable delay in gratification – let us consider for example rearing a child and the positive effects that empathy has on personality development, thus reducing crime rates for example. This fact is often overlooked because this produces the lack of something, which is clearly less outstanding than the existence of a phenomenon would be. Therefore intelligence by definition can be expected to be higher in a male population, but this is just a mere reflection of the fact that by intelligence we often measure some ability that men are good at. Baron-Cohen (2003) tries to go round the problem by suggesting a kind of emotional intelligence (originally by Goleman, 1996) which he terms empathising. The idea – as suggested by Goleman himself is not new, it has even been suggested that emotional intelligence actually counts for more when it comes to success in life (Goleman, 1996).

General intelligence scores on the other hand have often been associated with success in second language learning (Skehan, 1989, p. 21) as measured by reading abilities. A major finding concluded that foreign language aptitude measures, Vocabulary size at the age of 2-6 years and general intelligence had nearly the same predictive value in determining success at reading a foreign language at the age of 14. There are two contradicting facts uncovered so far: men seem to be superior in general tests of intelligence and intelligence scores are in correlation with attainment of second language learning. Nevertheless, it is generally women, who are found to be more successful at learning languages, which is usually explained by their superior verbal intelligence and better working memory, but in the light of the facts outlined above the consideration of other variables seems to be necessary as well. Taking into account Baron-Cohen’s (2003) theory, systemizing language would apply rather to knowledge of rules and structures of a language and in turn it would leave out a relatively important factor, communicative aspects. This would be underlined by the fact that some autistic spectrum disordered children might be able to learn various languages concentrating mainly on grammar, but they rarely use it to chat with other people, raising the question of what is considered a good attainment in second language acquisition.

3.3.1. 3D representation, spatial reasoning

There are several tasks that have a classical reputation in cognitive psychology to have a male superiority, such as mental rotation tasks, the Water-level task and the Rod and Frame test. The Mental Rotation Task measures the ability to manipulate 3D objects mentally. In general all tasks involving 3D coordination skills (such as assembling an apparatus or constructing block buildings). They outperform girls at a relatively early age (around 9-11 years) in transformation tasks from 2D to 3D structures, such as creating building block models on the basis of a blueprint, copying an array of 3D objects or imagining how a 3D object would look like if it is laid out flat (Kimura, 1999, 2004). According to Kimura (2004) 3D tasks are directly related to tests of navigation, both in simulation and in real life, and as such they can be assumed to be related to map-reading ability emphasized by Baron-Cohen (2003). The fact that men use more geometric cues in spatial navigation tasks, thus depending more on distance and direction, has become a commonplace, but as such it is difficult to refute. Baron-
Cohen includes this as a proof of the higher systemization ability for men, as changing direction and monitoring distance are more dependent on input-output operations. This can be easily argued however as it can easily be seen that landmark cues can be managed with the same IF-THEN operations. However the superiority of boys in sketching maps about an area well-known to them is well-studied and is backed up by solid evidence (Galea & Kimura, 1993). Moreover girls tend to overemphasize landmark cues on their maps, in contrast to boys, who are more keen on the accurate representation of routes and roads, thus emphasising the system-like characteristics of maps.

While spatial tasks and abilities, including 3D representation, mental maps and spatial rotation are usually treated by the theory of Baron-Cohen as a unitary monolith of abilities, however in the literature dealing with this phenomenon there are several suggestions to divide this ability to various subcomponents. The supposition that spatial abilities are one has been put forward by intelligence research and has been formulated in various models, such as those of Gardner (1983), Thurstone (1938) and Guilford (Guilford et al. 1982). It has come under criticism in the mid 80s, formulated by Caplan et al. (1985) and research sprung to life on this soil has proven that spatial ability might in fact be various abilities (as summarized by Quaiser-Pohl et al., 2004). Various suggestions have been put forward, with a varying set of factors from two to various.

She et al. (2001) suggested in a 20-year span longitudinal study that spatial abilities accounted for an important variation in adult occupational choice, indicating a stronger orientation towards science, architecture and engineering even after partialling out the effects of SAT-M scores, a general test in mathematics. They underline thus the importance of involving the measurement of spatial abilities in artistic, scientific and technical disciplines. However, they only examined the top 0.5% population in general intelligence, which restricts their results to the intellectual elite.

There is a long-ongoing debate on a special issue of this question, namely the relationship between small-scale spatial tests, such as the Mental Rotation Test and large-scale spatial representations such as maps and wayfinding. As Quaiser-Pohl et al. (2004) summerizes results exist supporting both parties, those supporting the independence of these factors and those in favour of their interrelatedness. Lawton (1996) has found that specific gender-related differences are related to spatial-perceptual ability. Both indoor and outdoor orienting was related to gender – more specifically women were more likely to use what he termed as route-dependent descriptions, which is very similar to landmark use, as they recalled the turns they had to take at each stage of their journey. Men on the other hand used orientation-based strategies in both indoor and outdoor wayfinding. Recent investigation of the Mental Rotation Task, the Rod and Frame task and the Water Level tasks have indicated that in fact the scores in these tasks seem to load on one personality factor (Quaiser-Pohl et al., 2004), which is however different from the ability to draw maps. Children who completed the tasks named above, were also asked to draw a map of their school area and the maps were coded in terms being landmark based or Euclidian distance based, which they reframed to be large-scale spatial representations. According to their results the representation of small-scale and large-scale spaces was different from each other. This undermines the claim that men are better wayfinders than women are, as this depends rather on the learned ability of how to use the cues that are readily available for each sex. Malinowski (2001) also notes that spatial abilities in general – and in men in particular – are not directly related to differences in spatial abilities, thus high scores in the above tasks do not necessarily indicate real world wayfinding, although a relationship is the subset of women has been confirmed (Malinowski, 2001).

Small-scale spatial abilities however, seem to be related to mathematical reasoning (Bishop, 1989) and computer knowledge (Quaiser-Pohl & Lehmann, 2002). However, one can not help but note that in recent societies the environment has changed very much to favour landmark
dependent strategies, as artificial environment is less susceptible to changes with seasons and natural death and regrowth. (Obviously, this latter reason is only valid in relation to biotic environment as non-biotic environment changes as little as artificial buildings. It can be reasonable to assume nevertheless that at least some hunter-gatherer societies live in areas where biotic environment is dominant, as would be the case for rain forests). The finding of the independence of spatial abilities and environmental maps in turn casts doubt on the hypothesis formulated by various evolutionary psychologists (e.g. Buss, 1995) usually designated by the term “Hunter-gatherer hypothesis” (detailed earlier) as this would depend on the close relationship between spatial ability and environmental knowledge. According to the theory context-independent spatial memory would support Euclidian distances representations and context dependent spatial representations would be a good basis for Environment based maps.

Quaiser-Pohl et al. however (2004) make notice that the Rod and frame test has lower correlation with the rest of the factor, and might have a separate meaning as a field-dependence indicator. They fail to explain however the theoretical difference between vertical and horizontal that should, in theory cause a difference between results on the Rod and Frame and The Water Level Task. It is also of concern in the study, that while spatial tasks tapped Short-term memory, wayfinding and map drawing depends largely on long term representations, which might itself lead to differences in performance.

Other researchers underline the relationship between visual cue dependence, as measured by the Rod and Frame Task and bodily stability in dynamic balance conditions, that is the stability when placed on a see-saw platform. Golomer et al. (1999) compared professional dancers and untrained subjects and found that the more independent they proved to be on the Rod and Frame task the smaller the amplitude of their sways was an unstable see-saw platform, while trying to balance.

3.3.2. Spatial cognition, attention to detail or field independence?

Baron-Cohen lists differences in various tasks, such as the Rod and Frame test or the Embedded Figures Test (originally described in Witkin et al, 1971) that were devised to test field independence in psychological literature (originally described in Witkin et al. 1962). Field independence is the ability to treat a target object independently from its environment or quoting the original words of Witkin (1977 – as cited by Richardson, 1998) field dependence is:

“the extent to which the person perceives part of a field as discrete from the surrounding field as a whole, rather than embedded in the field; or the extent to which the organization of the prevailing field determines perception of its components; or, to put it in everyday terminology, the extent to which the person perceives analytically” (pp. 6-7).

Performance on various tasks seems to indicate that males are better in these tasks than females are (Baron-Cohen, 2003, elaborated below). However the tasks mentioned by Baron-Cohen became more often associated with spatial abilities than with field independence in the mid 80’s, in recent literature the view that it should be an independent construct as returned to life (Quaiser-Pohl et al., 2004, see below). The Rod and Frame test was in fact at the outset considered to be a task measuring spatial abilities (Witkin &Asch, 1948), and only later has it been suggested that its scores might reflect something other than space-related cognition. The tasks presents participants with a rectangle tilted to wither side by 30-150°, and a rod, both of them luminous in a dark room in the original version, but replaced by black lines in the paper based version. However, the task is the same in both cases, requiring the participant to
establish the angle of the rod, such that it should be vertical, as if hung by a chord. The position of the rod related to true verticality is measured, and it is correlated with the changes in the direction of the frame. The measure is supposed to capture the extent to which the frame effects the line drawn in the rectangle (which in turn should not in fact be affected as the vertical direction does not change). The task was supposed to require the separation of the stimulus from the background, alongside with the Embedded Figures Test. In the latter a complex line drawing is presented to the participant, who is asked to find a simpler shape, that is included in the complex figure, however it is rather difficult to find due to the confusing set of distractor lines on the drawing.

The third task, called the Water Level Task Baron-Cohen mentions has not been associated with field-dependence, but was devised as a measure of intelligence by Jean Piaget himself, as cited by Baron-Cohen (2003). In this particular test the level of water has to be indicated in a bottle, that – similarly to the previously described Rod and Frame task – has been tilted sideways to some degree. Women tend to commit the error of indicating the level of the water as being parallel to the bottom of the glass, rather than horizontally and they are prone to fall for the same mistake in the Rod and Frame task, with the exception of course that they deviate from the vertical direction. As women are more often inclined to judge verticality as a function of the position of the frame, which should not have an influence, this is explained as a result of context dependence. As both the tasks have an objective good solution which is independent of the environment, the difference is often explained by the fact that women seem to be more distracted by context than men are – however this can be paraphrased as women being able to take context more into consideration than men do. Results on the NAVON task seem to support this main argument as higher scores in systemizing scores (as measured by the test developed by Baron-Cohen (2003), SQ the Systemizing Quotient test) correlate with local processing bias in the task (Billington et al., 2008). This suggests that higher systemizing skills are linked with a relatively good ability to attend to and concentrate on details. This ability, according to Billington et al. (2008) are reliant upon the left prefrontal cortical areas, which is generally held responsible for driving selection of task relevant information and maintaining an attentional set, thus it is generally more linked to attention than thinking or perception in general. Billington et al. (2008) further insist that the differences in brain activation are due to systemizing score differences and are significant even when sex is corrected for.

3.4. Some further notes on Field-dependence as a parallel frame to the socializing-empathizing dimension

Taking the field-dependence dimension into consideration one finds that its relationship with the theory of Baron-Cohen is more difficult to establish than it would first seem to be (a summary in Block et al, 1998). Following the uproar that responded to the various negative associations that the field dependent trait seemed to have, Witkin, the central figure and formulator of the theory, modified one of the central claims in his ideas. In the first version of the theory they claimed that field dependent people have difficulty in establishing close friendships and affective attachment as a result of their emotional immaturity (Witkin, 1962). In the later version, published by Witkin and Goodenough (1981), trying to effect a move towards value-neutered view, they claimed that it was in fact field dependent people, who could establish a healthy and good relationship with others, while field dependent people are superior in restructuring abilities. This version of the theory bears close relationship, albeit with differing terms, with that of Baron-Cohen, who would term field independent people systemizers and field dependent ones empathizers, although naturally his theory has a scope
far wider than that of Witkin. However this second formulation of the theory of Witkin did not turn out to be supported by facts, as Kogan and Block (1991) and Block (1999) have found that field independent children were more skilled socially and this effect, far from fading, became even more pronounced as time passed, with the result of 18-year-old children showing a marked difference between those who were field-dependent and those who were field independent. Field independent children, as Block has described them, were “well-rounded individuals, excelling in both the task motivational and social domains” (Block, 1999, p. 188). Additional relationship between parenting styles and field dependence is described in a later section of the thesis.

Meanwhile, the question of measurement and theoretical foundedness of field independence has come under question as well. Although many theories treat field dependence as a unitary monolithic mental structure, we find ourselves coming up against the same problem as with spatial abilities. If one examines the scores achieved on the Embedded Figures Task and the Rod and Frame test, it often turns out to be the case that the two are not correlated in people (see Richardson, 1998 for a summary). The correlation for the most optimist is only moderate, and Witkin et al. (1954) himself reports that the correlation was significant in a group of men, but failed to reach significance in a group of women. It is to be noted however that he used a sample of 46 people therefore well-founded doubts might arise as to the sufficient size of the group for correlations done with ordinal variables. Nevertheless, Tinajero and Páramo (1997) have found that while the Embedded Figures Test results were related to academic achievement, scores in the Rod and Frame task were not, therefore they themselves concluded that field dependence is in fact not a unitary but a bidimensional construct.

There were several concerns about the original Rod and Frame test, which being conducted in total darkness might well cause anxiety in participants. Therefore this gave rise to the possibility that results are affected by levels of anxiety, which is basically a non-cognitive factor (Richardson, 1998). This would give an alternative explanation of why women tend to be underperformers in the task, as they are likely to show stronger traits of anxiety which would mar their performance on the test. There is one line of research that would support the theory of Baron-Cohen though, which confirmed that the Rod and Frame test is in fact influenced more by sensory factors and has very little to do with higher level cognition. Even though Baron-Cohen underlines the importance to good attention to detail, which is difficult to be considered as a sensory functioning, yet it is far from the presupposed level of abstractness of field dependence.

The extensive criticism of the Rod and Frame Test gave rise to the preferred use of the Embedded Figures Test, however this has brought on new problems of interpretation as well. Although considered as a stable personality trait in the original field dependence theory (Witkin et al., 1967) and an ability in the interpretation of Baron-Cohen (2003), various line of research has shown that practice has a significant effect on the results, which Witkin himself pointed out (1954). Although personality traits and abilities are expected to remain relatively constant in adult population, task learning may well explain the improvement, however this reduces the validity of the measuring tool. Others suggested that field dependence as a trait does not actually measure a particular cognitive stile, but rather a person’s analytic functioning (Caplan&Kingsbourne, 1982), which would explain their correlation both with standard intelligence scores and academic success (Richardson, 1998). In fact, this is one of the main reasons for the conversion of the would-be neutral trait in a positive characteristics, as field independence has even been confounded with intelligence per se (Goldstein and Blackman, 1978, pp. 185-186.).
There has been a vast research on field dependence and parenting style and teaching. If field dependence was indeed related to the personality traits as Baron-Cohen (2002) claims it to be, then neither parenting, nor education would be expected to play a major effect in its development, as the traits put forward by Baron-Cohen are largely — though certainly not exclusively — biologically based. However various line of research showed (Kogan and Block, 1991, Block 1998) that parenting and teaching style are both associated with the field dependency in children, which would indicate a massive learning effect. Even in the original formulation of the theory on field dependence — which has never changed even with the continuous strive to make the theory more palatable to the taste of social justice (Van Meel, 1991) — a relationship between field dependence and harsh, abusive parental behaviour on the one hand and field independence and supportive behaviour encouraging the child’s autonomy. As this claim has never been change, a controversy became evident in the theory of Witkin et al. (1954) as exposure to harsh parenting practices was supposed to give rise to field dependence and thus good interpersonal skills which seemed to be both contraintuitive and lacking evidence. Kogan and Block (1991) however presented evidence that parental beliefs and the performance of children on the rod-and-frame task indicated that it was in fact field dependence that could be related to harsh, emotion suppressing parenting styles as opposed to autonomy-granting parenting that are rather associated with field independence. As the validity of the results could be questioned as some critiques Kogan and Block reported to receive which pointed out the difference between reported attitudes and actual action, they carried out a large scale longitudinal research that based both parenting style and field dependence under direct observation. Later the latter version of the theory was supported by evidence based on observation of parent-child interaction during problem solving and results on several versions of the Rod and frame test (Block, 1998). They also referred to this connection as one between teaching and field dependence as parents were interacting actively with their children in an effort to solve various tasks. This draws attention to the important role education might play not only in later intellectual success, but emotional coping as well. The endnote of these results from the point of view of the theory in question is however, that if field dependence and the proposed personality traits of Baron-Cohen are indeed to be related, there must be a strong social factor in the forming of these traits. This fact in itself would not contradict the empathizing-systemizing theory proposed, however the fact that good cognitive skills and good social skills are both related to field independence render it unlikely that they should be in negative correlation with each other, as would be the suggestion of Baron-Cohen’s theory.

Witkin et al. (1977) originally argued that field independent students organize the material presented to them by the teacher spontaneously, while field dependent students expect their teachers and educators to provide them with the structure of the material or as in an analogue situation they expect instructions and guidance from the experimenter in a laboratory based setting. Moreover the theory also suggested that field independent students would be more attracted to sciences and mathematics and engineering while field dependent students are lured by the classical liberal arts, such as social sciences, humanities and art. This would be in
line with the personality trait suggestions of Baron-Cohen, again suggesting that field
dependent people are similar to empathizers and field independent people are similar to
systemizers. The problem can be projected onto language teaching methods, as one could
hypothesize that field independent students would be expected to find language rules if
provided with sufficient data, while field dependent students would require preset rules and
explicit instruction. The thesis addresses the question of how results in empathising relate to
teaching styles, though its relationship with field dependence remains yet to be researched.
Although both Baron-Cohen’s idea and general discussion on field dependence suggests,
independent research or lonesome inquiries should be more adapted to a systemizer or field
independent mind. This suggestion however has not been borne out by evidence by field
independence studies – and though no studies of systemizing and distance learning have been
published so far, the authors own as yet unpublished research seems to suggest the same.
However the claim that field independent students would be more independent in their studies
has not been backed up by research. Moore (1976- cited by Richardson, 1998) supposed that
successful independent learning has to be based on personality characteristics that are very
similar to that of field independence. He underlined the importance of autonomy in following
courses and studies that are so heavily dependant on individual study programs and where
contact with teachers is severely limited. His argument shows an uncanny resemblance to that
of Baron-Cohen at one point, where he states that „by a self-selection process only those who
can tolerate non-social learning conditions survive in a program where dialogue is so low” (as
quoted by Richardson, 1998). The reasoning of systemizers tolerating solitude much more has
essentially the same thought at the core.
In a study Moore (1976- cited by Richardson, 1998) compared a group of students following a
distance course in the United States and another group of students assessed in an independent
study following a campus-based program at a Canadian University. Both groups were tested
with the Embedded Figures Test and filled in a questionnaire on their attitude towards
independent studying versus studying accommodated in a social setting. Results revealed that
compared with normative data, distance learning students indeed tended to be more field
independent. However, the data remain controversial as it seems that college students in
general seem to be more field independent than the population in general, a property probably
linked to the correlation of the trait with general intelligence. Accordingly, Moore has failed
to find a difference between the two types of college students, although he gave the
explanation of a probable cultural difference (however, this casts doubt on the original results,
as the normative data was assessed on an American population and the distance study sample,
as mentioned before was from Canada). The study reported furthermore that there is no
detectable correlation with the subjective rating of preference for an independent study and
field dependence. Nonetheless Moore has considered that student autonomy is a desired trait
in young adults and encouraged institutions to foster autonomy in distance education, going as
far as suggesting curricula and faculty plans.
Thompson (1984, cited by Richardson, 1998) conducted a similar study trying to establish a
relationship between distance learning and field independence, but his results are equally
unconvincing, as using the Embedded figures Task he only replicated the fact that compared
to normative data, distance learners have a higher score in field independence, this difference
however was confined to females with no difference detectable in males. Moreover, contrary
to his initial hypothesis, field dependant people were slightly more likely to finish a distance
learning course (60% of them completed their studies, as opposed to 54% of the field
independent group). Subjective ratings on the enjoyment of distance learning were in line
with suppositions and field independent students seemed to be more content with the course
and their studies in general. Thompson’s argument in explaining the results (or to phrase it
more exactly, the lack of results) as he referred to the fact that people in the field dependent
group were unrepresentative of their population, as they were less sensitive to the lack of immediate contact and structured education inherent in distance education. This argument undermines his entire hypothesis though, since the initial supposition was to prove the relationship in the other way round, and the way “not representative” is defined referring to the field dependant subsample is based on their university achievement, making the argument entire circular, as pointed out by Richardson (1998).

3.4.3.  Movements and motor actions

There are certain motor tasks that men have more aptitude with, although there is a debate on what exactly the nature of this difference is. Baron-Cohen emphasizes that men are better at motor actions such as throwing and catching that he interprets this to be are system-based in some way, as is the case in sports when more muscles have to be coordinated in real time. However, it has to be noted that men have generally more stamina and considerably more physical force, making them more inclined to do such sports, while the fine motor coordination skills of women might make them slightly disadvantaged in these fields. This is however contradicted by the fact that men are better at predicting flight trajectories perceptually as well, which has nothing to do with physical force or stamina (Schiff & Oldak, 1990). Evolutionary accounts in this field might be slightly more credible as men are the hunting sex in all societies (Gaulin & McBurney, 2000) and therefore an evolution of highly developed skills in the manipulation of objects moving on a trajectory would be explainable in two ways. It can be argued either that men at some point in evolutionary history developed a higher skill in throwing and catching and therefore became the hunting sex, yet the explanation that would go another way round would be even more reliable. Women as primary caretakers could hardly take off enough time to devote to hunting animals that might even need an expedition of a few days, and therefore it was incumbent on men to take up this role, who in turn have developed skills that are well-adapted to this task. It is not entirely clear what makes gross motor movements or throwing and catching parts of systemizing, while fine motor movements seem to be independent of this, however the male advantage remains unrefuted in the former, while women seem to excel in the latter.

3.4.4.  Natural classification systems

Another evidence brought forward by Baron-Cohen are the similarities between the categorization of local specimens into species and different categories by the Aguaruna people in northern Peru and that of Western biologists (originally described by Medin & Atan, 2004, Bailenson et al, 2002). The similarity of categorization mentioned seems to be present only in men, who base their categories on the skeletal structure, habitat type, feeding habits and even their relationship to humans, while women are reported generally to concentrate on more static traits such as colour or shape. However Baron-Cohen himself (2002) recognizes the weakness in the argument, which would consist in the fact that most western science biologists are men. Nevertheless this does not undermine the main proposition, namely that a difference seems to exist in the cognitive structure between men and women. The fact that men seem to like sports more than women do is also associated with their preference for classification, as most team sports lend themselves to different classifying schemes, such as league tables and player classification lists. Detailing the evolutionary advantage of organizing animals in categories Baron-Cohen (2003) mentions that predictive power of behaviour is increased if the right category is found, such as knowing which snakes are poisonous or which mushrooms are edible. It is arguable though how this information would be advantageous for men and yet not attributing to the survival of women.
3.5. The Systemizing quotient – self-assessment tests developed

Based on the supposed characteristics of systemizers Baron-Cohen and his research group (Baron-Cohen, 2003) developed the Systemizing Quotient test consisting of 40 items that requires the self-evaluation of the participants interest on various fields of systems, including abstract systems, natural systems and technical systems. There are 20 filler items, thus making the entire questionnaire 60 items long. Their research has shown that men are likely to attain higher scores on the test than women are because of their more pronounced attraction towards systems in general. The test seems to be valid across cultures as well, with results on Japanese samples presenting the same distribution (Wakabayashi et al. 2007). Although the test has proven to be composed of a simple factor, not all items load on the general score equally as Wakabayashi et al. (2006) noted, and a 25-item shorter version of the test was developed as well.

4. Empathising

Empathising in the definition of Baron-Cohen, involves attribution of mental states to others and an appropriate emotional response to these mental states. His former theory presented a similar mechanism that was termed mindreading (1994), defined by Baron-Cohen as ‘the ability to interpret one’s own or another agent’s actions as driven by mental states’ (Baron-cohen, 1994, p.724), although this is confined to cognitive aspects of the task. The original model had only four subsystems, (it was comprised of an Intentionality detector, an Eye Gaze Detector, Shared Attention Mechanism and Theory of Mind- see below in detail), which were later extended to six in order to contain affective aspects as well. In this sense it surpasses the terms discussed earlier as “theory of mind” and “mentalising” as it has an emotional connotation to it that confers it a meaning related to empathy or sympathy. According to Baron-Cohen, empathising involves “an imaginative leap in the dark” (2002, p. 248) which is not as strict and tightly rule-governed alone but involves what one might call intuition on the mental state of others. However this “intuition” is not without a basis, it is dependant on the perception of small non-verbal cues, which – interpreted correctly – can enable one to examine the truth value and attitudes of another conscious agent. It is most likely derived from both intralinguistic (pitch, intonation) and extralinguistic (body language, facial expressions) non-verbal signs that are constantly emitted via various channels.

There are various reasons most agentive behaviour can not be systemized, the main reason being complexity and the lack of a determined relationship between observables – such as facial expressions – and underlying mental states (Baron-Cohen, 2006). There are some laws governing behaviour, but they are inadequate in explaining everyday behaviour. First of all, these laws are generally probabilistic rather than absolute, though this in itself should not lead to the consequence of being resistant to be systemized as weather changes are probabilistic, yet meteorology is a science rather than an art of divination. As a second reason one might mention that if rules can be established between stimuli and reaction, they are very basic level and hardly useful in everyday contexts, such as observations made by behaviourists on how dogs would salivate if presented with food. Skinner (1976) himself believed firmly that behaviour can fully be explained if all the previous historical events and all consequences of an action or behaviour were known. However if such rules do in fact exist, modern psychology is a far cry from the complete explanation and knowledge of such rules. Other highly determined actions are those that are evolutionary hard-wired to avoid conscious pathways, commonly known under the term of reflexes, that occur reliably every
time a stimulus is presented, unless a serious neurological damage has occurred to the nervous system. Baron-Cohen (2006) points out a third case where human action is predictable, which is the case of scripted events, however very few events are scripted in such an inflexible manner that they could be systemized. Supporting this argument one could bring up the example of scripted events in official state or high-level organizational meetings and argue that the protocols governing political events are so far developed because of the overrepresentation of systemizers in politics.

Another line of argument mainly relies on the impossibility to solve complex agentive behaviour – such as which would characterize humans – because of the massive computation that would need to be done because of the vast number of possible combinations that are possible taken into account gestures, posture, facial expressions and other related features of non-verbal communication. Moreover people can not be considered as a single category as they react to situations differently, therefore it would be necessary to try and systemize every single person individually.

Empathising has various mechanisms suggested by Baron-Cohen (for a summary see Baron-Cohen 2006), all of which is to be elaborated in the following sections. One of them is the intentionality detector, that is intended to interpret the goals of an agent with self-propelled movement which is an in-built mechanism to detect the aims of an entity with volition. The Eye Direction Detection (EDD) module is an automatic detection mechanism of eye-like stimuli, not only detecting the presence or absence of eyes but also their directions, with a special emphasis of gaze directed at oneself. Detection of diverted gaze can be conceived as the basis of joint attentional mechanisms or in the terms of Baron-Cohen himself, as Shared Attention Mechanisms (SAM) that can be argued to be at the heart of language learning as a necessary requirement of finding the references of words in the real world and thus building up a vocabulary (Baron-Cohen, 1995). Theory of Mind mechanisms (TOM) are more complex and allow an epistemic representation of the mind of another agent, in short allowing to represent the thoughts, attitudes, beliefs and desires of others and the relationships between these mental states. As this is a more complex functioning, it develops much later than other components mentioned above, which are present in infancy already, yet TOM only reveals itself around the age of 4 years. There is more to empathizing however than representing the thoughts of others, and affective stimuli seem to form a special subset of interpretation of other agents, forming an Emotion Detector (TED), which represents basic emotions, described by Ekman early in the 70s (Ekman, 1972). The Empathizing System on the other hand allows not only the representation and understanding of basic emotions, but also the adequate and automatic empathic reaction to them (Baron-Cohen, 2005). The development of these submodules is quite diverse, with the Intention detection and Eye Direction module developing very soon by the age of 9 months it is well-developed, though its traces can be found even on the first days of life (Baron-Cohen, 2005). Shared Attentional Mechanism is bound to develop around between 9 and 14 months and form the basis of both Theory of Mind mechanisms, which seem to be fully developed by the age of 4, somewhat later than the Emotion Detector, that becomes detectable at 14 months in infants, soon after the appearance of shared Attentional mechanisms.

5. Theory of mind

An overwhelming amount of what children learn is mediated by other people in their culture. (Birch et al. 2008) While true of any society among humans this is even more salient in modern western societies where school education takes over the learning processes of children. Learning from other human beings depends heavily on the ability that cognitive
psychologists have named the “theory of mind” and what recently re-emerged as the intentional and later the pedagogical stance (Gergely and Csibra, 2003). In second language acquisition the ability to represent other minds becomes even more crucial, since it is a communication-based task, where understanding intentions is inevitable. Yet theory of mind and intention seeking is just as natural to humans as language is and arguably just as exclusive providing a natural parallel. As Meltzoff (1995) points out it is so deeply rooted in our thinking that describing people moving in terms of twitches of the hand and arm movements would produce a profound puzzlement in the listener. Human action is a perplexing “jumble of behavior” and a set of “bewildering series of movements” without recurring to the intentional stance to explain it (Meltzoff, 1995, p. 838.).

Theory of mind refers to the ability to attribute mental states – beliefs, desires, knowledge – to others and to understand that these mental states can be different from one’s own. The term was originally proposed by Premack and Woodruff (1978) in an article suggesting that chimpanzees might have a similar mechanism to interpret conspecifics’ minds. Later child psychologists adopted the view in trying to answers questions about the development of perspective taking in children (Leslie, 1987). The crucial importance of theory of mind from a pedagogical point of view is emphasized by Wellman & Lagatutta (2004) as we shall see later. This ability is pivotal for social interactions in larger groups, therefore it can be assumed to be present among all vicarious species. However, along with the evolution of language it has taken on a different perspective

Dennett (1989) proposes that human beings – or any living organism for that matter – are thought to be best interpreted via what he calls an intentional stance. He originally describes three explanatory stances towards the world, which can each serve as a base for different explanatory factors in Second Language Acquisition, although as I shall outline later, from our point of view only two are going to be of major relevance.

The first of Dennett’s stances is the physical stance that explains phenomena in terms of velocity, mass and energy. Naturally occurring phenomena in the non-biological world are good candidates to be explained with the help of the physical stance which as a philosophy has gained itself much appraisal in Western philosophy as being a „rational” perspective. The second stance is the design stance that presupposes that man-made objects have a specific purpose and were designed to fulfil that purpose – we do not need to understand the electromagnetic laws governing lamps in order to be able to switch them on. The third perspective is generally applied to biological organisms that are supposed to have their own intentions, thus it is named the intentional stance. The intentional stance is used to predict the actions of people based on their beliefs, desires, and thoughts. This latter stance gains its importance because of its special role in communication, as this is the only stance that provokes communicative actions.

The difference of these three stances can be explained with the amount of unpredictability that they contain from a third party perspective. Non-biotic (non-living) phenomena have a very restricted unpredictability rate and careful observation of physical circumstances around them often explains their behaviour. From our point of view the design stance is not much different – though it can not be fully explained by sheer laws of physics, the predictability of these behaviours is still fairly high – unless the artefact in question are broken of course, therefore we shall treat these stances together and refer to it generally as a raw rule-based stance. However there is a gaping chasm between these two stances and the intentional stance. The predictability of the living environment, people in particular based on merely physical circumstances is extremely low, as in opposition to the other two mentioned before, as goals in general have to be taken into account.
5.1. The Intentional stance and empathizing

The intentional stance (Dennett, 1989) presupposes what we earlier mentioned as Theory of Mind, which makes the entire stance possible. The novelty in Baron-Cohen’s theory is that he draws a parallel between Theory of Mind and empathy. However there is a difference between the two concepts even if it is only a connotation-based one as Theory of Mind is linked to “cold cognition”, the manipulation of mental representations without the influence of emotions, whereas empathizing supposes tuning into the feelings and emotions of another being. As theory of mind has been investigated longer in cognitive psychology, we shall examine this notion before going on to its supposed relationship with empathy.

In interesting piquet of theory of mind is that it has two competing explanations in current psychology – one of them is the theory-theory, the other being the simulation theory (Leslie et al., 2004). According to the first, during the early years of development we develop a theory about the beliefs, desires and thoughts of others that we are able to use aptly to predict the behaviour of others and children act as small scientist in trying to make out the reasons for the bahaviour of others (Perner, 1995). However as Leslie (2004) points out supposing this might be attributing abilities far beyond the capacity of young children, as in accordance with this it should be equally likely that they develop theories on mechanics or genetic codes, as the effects of these are just as observable as that of theory of mind, but children simply do not pay heed to that. It is important to underline that the theory theory would nearly completely equate Baron-Cohen’s two mechanisms, if we are to understand theory meaning that a set of rules describing the functioning of the system. However such a drastic step is only necessary if we consider this theory a conscious one, and not an innate and automatic process, such as colour vision is. The other explanation would be simulation theory which would posit that when predicting the actions of others, we simply step into their shoes and try to imagine what they feel, thus mimicking the mind of the other to get the right response.

A similar formulation to simulation theory date back to as early as Baldwin, who suggested that the understanding of others goes in tandem with the understanding of the self (cited by Symons, 2004). The realization that the bodies of other people contain and hide feelings that the child him/herself has is a crucial step in understanding others and developing a theory of mind. However Baldwin also underlines the importance of the origins of theory of mind and its dependence on social constructs and thus places the faculty in a social interaction setting. Cooley provided a similar suggestion with the conception of a looking-glass self, a social mirror to the internal states of mind of the child, which would support the understanding of others. Piaget emphasizes both cognitive and interpersonal factors which is well-described by the use of the term reflective consciousness (cited by Symons, 2004) whereby the self can reflect upon itself when entering the stage of formal operations leaving egocentrism behind. The differences and similarities of the two models shall be discussed later, highlighting the importance of the distinction from the point of view of Second Language Learning.

5.2. The development of theory of mind

The development of Theory of Mind seems to be somewhat universal as recent meta-analysis have shown (Wellmann et al. 2001). The time course of its development seems to be impervious to cultural and linguistic effects and seems somewhat robust to educational effects (de Villiers, 2007).

A task that can conceived to have measured something that bears close connection to a theory of mind has been investigated by Piaget himself in the last century (Piaget and Inhelder, 1962, 1967). The ability to decenter was theorized to be a key ability in perspective taking, the ability to experience and describe the same object from different vantage points. Piaget has supposed that in order to be able to take different perspectives both the differentiation and the
integration/coordination of viewpoints is necessary as is anticipation to move to another vantage point. This can be considered as a first case for a theory of mind as it involves having to represent the fact that another viewer might have a different idea on the appearance of a scene. The original three-mountain-task exploits the fact that the perspectives of two or more protagonists are at odds with one another and the child therefore has to give a different answer to a question that his or her own perception. In the classical three-mountains-task children are presented with a small model of three mountains, which are easily distinguished by their different colours and varying shapes. The model is put on a table and four viewers are seated around it, one of whom is the child him/herself, each of these characters therefore has a particular viewpoint of the model. The child is asked to describe what the other protagonists see of the mountain and the answer is coded according to the number of features the child was able to describe that is in line with the perspective in question. Having administered the task to 4 to 12 year-old children, and they found that up to the age of around 10 children are not capable to answer questions concerning the descriptions from another point of view and instead they produced “egocentric” descriptions, descriptions that were based on the child’s own point of view. The explanation was based on the child’s inability to de-center, which would roughly mean the ability to put oneself in someone else’s shoes, moving to another point of view, taking another perspective, understanding that another person might see things differently from ones own point of view.

The task of Piaget and Inhelder (1967) is arguably too difficult for children to accomplish, considering the verbal difficulties of description and the memory load of the task. Flavell (1988) argued that it might not be the ability to de-center that is at the heart of the problem in children’s failure at the task, but rather their difficulty in keeping all the relevant positions in a 3D space in their memory at the same time – therefore it is more of a problem in working memory space and monitoring abilities, rather than the shortcoming of the ability to de-center. The necessity of transformations aggravates the problem further as children need to update necessary changes in the descriptions of the scenes as front becomes back and left becomes right (this latter being a particularly difficult transformation).

Flavell and his colleagues (1988) have therefore modified the experiment to simplify the task that needed to be overcome by children. First of all they reduced the three dimensions to two and they also simplified the images, having a cat on one side and a dog on the other side. In this setting children as young as 3 or 4 years old could tell if the person in front of them sees a dog or a cat. The problem therefore in the task devised by Piaget is probably not perspective taking alone, if it was, simplifying the task would be of no use. The conclusion that can be drawn is that if there is a single relation (between the cat and the dog) and a single transformation (if one person sees a cat, the other one will see the dog) then children are able to pass tests of perspective taking around the age of 3 or 4.

This is all the more interesting, because of another line of studies has found that in a similar task it is around the age of 3 years (somewhere between 3 and 5) that children begin to form a representational model of mind (Meltzoff, 1995). In contrast to the spatial perspective taking task, the task devised by Wimmer and Perner (1983) is based more on a psychological perspective taking as it sets out to test if a child has acquired the ability to represent other minds, called the false belief task. The classical task – originally called Maxi task but its later version the Sally-Anne task became more popular (Leslie et al. 2005) – is usually played with puppets in front of the child. Usually Sally comes in, gets out a bar of chocolate somewhere, then goes out. Anne comes in and puts the chocolate somewhere else, then leaves and the scene is stopped with Sally re-entering the room. The child is asked where Sally will look for the chocolate, and he or she is supposed to possess a full theory of mind if she can answer correctly. The task has been named false belief task because the child is expected not only to represent a past state of affairs in the world (this being one of the control questions) but also
that this representation is still held as valid in another person's mind. With innumerable variants over the years the false belief task has at its heart two properties (Russell, 2005). First, there is a state of the world that children know about and which they can perceive and second, there is another non-veridical, or at least apparently non-veridical representation that they are asked about. Children can pass the Sally-Ann task generally by the age of 4, except for some pervasive developmental disorders, such as autism and Asperger syndrome. The ability to pass these tasks can be explained in two ways, one being due to a maturation of inhibition (whereby children gradually learn to inhibit the prepotent answer of what they know about the current state of affairs), while the other positing that children acquire more robust and stable conception of mental representations (including non-veridical ones).

In addition to cognitive theories on the development of a theory of mind, various social and cultural propositions have been put forward (Symons, 2004). There is for example a supposed relationship between attachment of children and parents and security seems to play an important factor in the speed of development of a theory of mind (Fonagy et al. 1997). Earlier Bowlby (as cited by Symons, 2004) suggested the importance of internal working models on theory of mind to help children work out how self and other behave on close personal relationships.

5.3. **Hardwired mental modules for theory of mind**

The modularity of mind has first been proposed by Jerry Fodor (1983), who pointed out that basic functions of the human mind are remarkably fast and surprisingly unchangeable, and offered the solution of modularity in order to account for this phenomenon. Modules are autonomous and encapsulated information processing units that are domain specific and whose processing is obligatory. His often cited example is vision, where obligatory processing is obvious (once one opened his/her eyes one cannot choose not to see) and domain specificity is evident. It is encapsulated in the sense that visual illusions pertain even if higher-level processes have discredited the illusion. One strong supportive line to modularity comes from evolutionary psychology, whose advocates argue that modules are hard-wired into the mind by evolutionary pressure (Cosmides & Tooby 2005). The argument of evolutionary theories is that the mind has its specializations just as much as the body itself has and despite the apparent homogeneity of the brain, it is in fact a storehouse of different survival tools, as different as a liver would be from a kidney. The immediate question that surges upon these grounds concerns the exact nature, number and function of modules and this is where much debate has gone on in evolutionary psychology, much of which we shall not discuss here. Suffice it to mention that there had been suggestions ranging from language acquisition modules to cheater-detection modules and even spider-detection modules. By definition modules need to be simple, so a proposal to include a theory of mind per se would be easily refuted. However there had been different claims as to what could form the basis of a theory of mind in young children.

5.4. **Early goal-directedness in children**

The earliest manifestation of the intentional stance has lately suggested to be the emergence of understanding of goal-directed actions, recently rebaptized as the teleological stance that has been formulated originally by Gergely &Csibra (2003; Gergely et al. 2002) and later developed to the concept of pedagogical stance. It has to be noted that originally Gergely &Csibra did not consider this stance to be a mentalistic representational system, or in other words they did not consider this to be equal to a theory of mind. They do, however insist on that it is a precursor of the ability to form a theory of mind, which only develops later on. This
stance however serves as a rationality principle necessary for interpreting the actions of others. The phrase „rationality principle” is intended to mean that children entertain the presupposition that actions function to realize goal states, taking into account situational constraints. While mentalistic or intentional stance does not seem to develop until the age of 4, the teleological stance has been shown to produce an effect by the end of the first year, when children become capable of interpreting and understanding certain sophisticated goal-directed actions. Gergely and Csibra (2003) have shown that children begin to show sensitivity to goal-directedness using computer animations in a violation-of-expectation paradigm. They showed a small circle jumping over a rectangular obstacle to a larger circle, and after habituating 12-month-old babies to this scenario, they took the obstacle away and either showed the same action, with the smaller circle jumping to evade a non-existent obstacle or they presented a novel, yet more rational action in which the smaller circle simply rolled over in a straightforward motion to the other circle. They measured the length of looking times to these two different scenes and they found that babies looked longer at the familiar action of jumping—which is suggested to indicate an effect of the result of the „violation of expectation” – than at the novel action of moving in a straight line, in spite the fact that this motion was completely novel to them. These results can easily be debated on several grounds, some of which reach back to the bass of the experiment, such as the in clarity of the meaning of the change in looking times, which is sometimes interpreted as a „surprise effect” (Gergely & Csibra, 2003) and as such is certainly a product of the intentional stance and a theory of mind constructed in the heads of adults about mental structures of babies, while we’re certainly still in the dark about what really is happening in the minds of infants, which blurs the exact underlying principles. Other studies stress the often overlooked importance of the individual differences between the responses of infants (Snyder et al. 2002). Gergely and Csibra (2003) themselves underline that these results can be interpreted to indicate three different conclusions. First they conclude that babies have the capacity to interpret actions of others as goal directed actions. Secondly, after taking into account all the possible constraints and obstacles for an action, they are aware to the most efficient way of approaching the goal. The third interpretation would be that children actually expect the agent to act in the most rational way possible under the circumstances.

Premack (1990) proposes that infants have a pre-wired, in other words pre-programmed inclination from birth to denote special importance to motion. As a consequence they divide the world based on the motion patterns of objects, thus creating two categories, that of self-propelled and that of non self-propelled objects. According to his assumptions this is the point where the concepts of causation and that of intention diverge, as changes in the direction of motion in nonself-propelled agents is perceived as a consequence of another agent, thus causality, while changes in the motions of self-propelled agents are conceived as intentions. He posits that while causality can be explained as an emergent category based on temporal and spatial contiguity upon perceiving the changes of motion of an object, theory of mind can be perceived as a hard-wired system to explain the changes in motion of self-propelled objects. They claim that children from a very early age are attracted to self-propelled objects and they also expect self-propelled objects to have a certain preference for each other over non-self propelled objects. In habituation studies children were shown to pay much more attention to the distinction of self-propelled versus non-self-propelled, that to other superficial properties, such as colour. He also adds that infants may attribute more than mere intentions to an agent; they can attribute preference or beliefs. Curiously, he also attributes the ability to learn from a very early stage, which would underline the importance of a pedagogical stance in the human species. In one experiment they have shown using again the habituation paradigm that children expect an increase in the performance of a self-propelled object (for example in dancing) and they are surprised to see a decline in the performance. In its essential
it would be this self-propelling capacity that serves as an innate cue to suggest children that the object is intentional and thus is capable of learning, teaching and beliefs in general.

5.5. **The gap in the intentional stance and theory of mind**

The question emerges however about the gap between the age children are shown to be sensitive to goals, at which time they are no older than 12 months and the age they can already pass more complicated theory of mind tasks, which – in the case of false belief tasks that we are to elaborate on later – does not happen until the age of 3 or 4 years.

One approach to the problem has been assuming that actually there is no qualitative gap between the two and the ability of interpreting goals is no less than a preliminary ability to attribute mentalistic stance to other agents and thus, possessing a theory of mind (Kelemen, 1999). This interpretation would generously endow children with the ability to attribute desires to animated objects (such as the desire of the small circle to get to the larger one) and belief (for example that the obstacle is impenetrable). There have been various mechanisms proposed in order to explain the early appearance of this ability some of which evoked modularity or hardwired mechanisms in babies (closely resembling those assumed in the case of language, to be discussed later) (e.g. Baron-Cohen, 1994, Premack, 1990), while and others supposing imitation and lately mirror neurons to lurk behind the phenomenon (Tomasello, 1999; Meltzoff, 2002), which shall all be discussed in turn.

5.6. **The Eye Direction Detector – on the importance of eyes**

Baron-Cohen emphasizes another module; the „gaze direction detection” module (commonly referred to as EDD or Eye Direction Detector) that lies behind the mechanism of intention reading or in his phrases mind-reading (Batki et al., 2000). However, as noted by Farroni et al. (2006) different theories on eye gaze processing often differ at least on two dimensions, one of which concerns its dependence on experience and the other its independence of other modules. While because of the low visual acuity of infants dependence on experience is a difficult issue to address, Vecera & Johnson (1995) argue that the ability to detect direct gaze is not independent of other modules as both infants and adults perform better with real faces than with scrambled faces, which is further corroborated by the findings of Farroni et al (2006), who have found that inverted faces fail to produce the same effect in newborns, and therefore a gaze-direction module would – at least initially –be dependant on whole-face processing.

The preference of faces over other types of stimuli has repeatedly been observed and confirmed in the psychological literature, however initial assumptions emphasized that visual acuity of neonates allowed for nothing more than seeing and orienting towards any face-like three blobs (as in an arrangement of two eyes and a mouth) in their surroundings. Batki et al. (2000) however considers that contrary to this theory eyes and gaze direction are evolutionarily biased to have special importance as recognizing oneself as the focus of attention can be indicative of the intentions of another being, which – if correctly identified – can save the beholder from attacks. As both Baron-Cohen (1995) and Bátki et al. (2000) underline the role of this early alarm system might be supported by the fact that most animals are indeed aversive to keep eye contact for extended periods of time. Baron-Cohen (1994, 1995) therefore posited a special module in the primate brain called an Eye-Direction Detector (abbreviated as EDD). In humans the EDD does not only detect eye gaze direction, but also constructs a dyadic representation of the other person’s behaviour, which is none less
then the beginning of a theory of mind. Many lines of research seem to support the importance of this gaze direction module in young children, such as infant studies that repeatedly prove that babies as young as 2 months old have a preference to look at the regions of the eyes (Hainline, 1978) and at 5 months they are already sensitive to gaze direction and in preferential looking tasks they are able to discriminate between direct and averted gaze (Vecera & Johnson, 1995). Bátki et al. (2000) have even proved that there is a sensitivity to human gaze in newborn infants after only a few hours of emerging from the womb. Moreover in adults there seems to be an automatic and obligatory force of human gaze which directs attention into the indicated direction, and it facilitates answers in an attention task (Posner, 1980). This is even the case if participants are overtly instructed to ignore the cues or if the cues are not at all predictive about where the stimuli are going to occur (Driver et al., 1999; Friesen & Kingsone, 1998; Langton et al., 1999). The phenomenon however, is by no means confined to the human species. It has been shown that infant chimpanzees (Myowa-Yamakoshi et al., 2003) are also sensitive to gaze direction, as they have been shown to pay more attention to open-eyed than to closed-eyed photographs of human faces, and they also tended to look longer at direct gazes (meaning that the eyes in the face seemingly fixated on them) than indirect gazes. Chimpanzees seemed to prove the innateness of this gaze-direction module as they showed these preferences already at the age of 10 weeks and the pattern of looking has not changed significantly after this period. However, it can not be left unmentioned that the faces used were human and the chimpanzees were reared in a primate research centre, and thus were in constant contact with humans, and therefore the results might be marred with artificial side-effects. Also it is inevitable that all problems previously discussed about preferential looking paradigms arise again, even more so as Mendelson et al. (1982) found that rhesus monkeys for example tended to avoid looking into the direct gaze of conspecifics, rather than stare right into them, therefore making preferences and all conclusive theories based on these preferences unstable. Yet neurophysiologic research on macaque monkeys indicates the same, supported by single cell recording data that proves that neurons that are especially sensitive to the direction of the gaze of other conspecifics (Perrett, 1992). Macaques also show galvanic reactions and augmented brain stem arousal if detecting direct eye-gaze (reported by Bátki et al. 2000). All neuropsychological evidence seems to pinpoint this mechanism to the superior temporal sulcus of the brain, including functional neuroimaging imaging studies and lesions studies.

5.7. Imitation – an alternative to gaze direction

Other explanations for an early theory of mind consider imitation or simulation to be at the heart of the problem (Tomasello, 1999; Meltzoff, 2002; Goldman, 2006). Tomasello (Carpenter et al., 1998) emphasizes the tardiness of an explanation operating with a huge cohort of modules to account for every flinch of the eye of an infant and proposes instead that the only mechanism needed to explain social cognition in infants is imitation or simulation, which is an identification-based behaviour match between an observer and an actor. However it has to be stressed that imitation is not mere mimicking. Superficial repetition, which reproduces the means of an action, much like a parrot regurgitating overlearned words is in the scope of basically most of vertebral species. However the expertise of the human race is mirroring the actions of one another that is not precise but based on copying the intention of the other person. Tomasello differentiates emulation learning that reproduces the end or goal of an action without reproducing the exact behaviour that lead up to this goal and imitation, which reproduces both the goal of an action and the behaviour by means the aim was intended to be achieved.
The age at which mere reproduction of the actions of others starts is debated, even neonates were shown to be able to imitate facial emotional expressions, however, it is only at 6 months that infants start to copy the actions of an adult executed on or with an object (Barr et al. 1996). It seems that it takes them further 6 months to achieve the ability to imitate actions. Meltzoff (1988) designed an experiment in which children were expected to reproduce the actions of an adult with an unusual sequence of movements, such as turning on a lamp by bending down and touching it with their forehead, while they could easily have managed to turn it on by pushing it with their hands. Meltzoff (1988) showed that children of 14 months were disposed to copy the behaviour even a week after the experiment, and Tomasello (Carpenter et al., 1998) further proved in an experiment that extended the age from studied from 9 to 15 months that infants at around 13 months start not only to imitate the action seen by the adult, but they also turn their eyes towards the lamp as if expecting it to light up.

A more elegant proof of imitation appears at the age of 18 months as Meltzoff (1995) has shown that children start to imitate failed actions of adults, with reproducing an actual result that they have never actually seen to happen (because the attempt failed). Children saw an adult trying to play with a toy, but not managing for example because his hands slipped in the action and the toy fell, however care was taken that the child perceived that the intention was to pull the toy apart. It is curious that the researchers were especially keen in this case not to give any emotional sign of a success or a failure in the task, opposed to later experiments which made use of intentions that can be spelled from the emotions present. Children in Meltzoff’s experiment imitated both observed actions and concluded and performed the goal of the failed attempts of the experimenter, however, they failed to do so when the experimenter did not show a specific intention with the toy but was only toying around with it. He has also reported that a number of children in this control condition were trying to imitate the movements that the experimenter showed them while idly handling the toys without any obvious goal. Meltzoff has also shown that this effect was specific to human actors and it did not appear if the same action was carried out by a set of pincers and not a person, therefore reflection real psychological and teleological assumptions in children and not just an urge to enact an end-state of a transformation. This also suggests that physical causality and the attribution of intention are indeed two different mechanisms and children learn to differentiate between them at a very early age.

Meltzoff (1999) overtly states that imitation is not just related to, but in fact is a basis for theory of mind. He proposes that non-verbal imitation is a “jump-start” (Meltzoff, 1999 p. 261) to theory of mind as children presume from the start that other people are just like them, which would be an good beginning for a theory of mind built on simulation. Early imitation is the proof that infants can make a connection between internal states and physical instances of the external world. It is not only infants though who imitate adults, but adults also imitate their children, and such a bidirectional imitational mechanism is supposed to be the start of a communicative relationship and the basis of social interactions (Meltzoff, 1999).

The imitation of facial expressions was considered another breakthrough in the development of cognitive science (for a discussion and summary see Meltzoff, 1999). As the age at which children started to imitate facial expression decreased the major foundations on the understanding of social interactions and nonverbal communication. The age at which infants started to imitate facial expressions (in typical experiments lip and tongue protrusion) was posited to be between 8-12 months, with the supposition that at an earlier age they did not have the capacity to line up observed features in the change of an adults face and their own motor movements. Meltzoff and Moore (1977, cited by Meltzoff, 1999) showed that contrary to this assumption children as young as 2 or 3 weeks old were capable of imitating facial expressions such as mouth opening, lip protrusion and simple finger movements. The results were replicated on various cultures (as summerized by Meltzoff and Moore, 1997) and they were
even extended to babies as young as 32 hours old. It seems to be undeniable in the light of these facts that at least some capacity to imitate must be present at birth (Meltzoff, 1999). The key feature of the model of Meltzoff was Active Intermodal Mapping (AIM) which posited that newborns have a hardwired ability to connect observed visual stimuli of facial features to their own proprioceptive sensations, which is the basis of the capacity to imitate.

Tomasello (2006) considers language to be none less than a special sort of social interaction mediated by linguistic symbols and as such it is based on the same mechanisms that social cognition is. Language is just a development and learning of a set of cognitive conventions that facilitate social interactions and as such its development depends on the development of social cognition, such as the ability to participate in joint attention-based activities, understanding communicative intentions and pragmatic inferences, perspective taking and maintaining conversation. The view of Tomasello considers language as a by-product of striving a good code for effective communication and in his conception social interaction clearly precedes language. This view of language acquisition and linguistic functioning would however entail that language acquisition is dependent on or determined by social aptness or mentalizing. Some developmental disorders seem to undermine this theory as they show a modular impairment of one or the other faculty, autistic spectrum disorders being considered a mentalizing deficit in its essential by a large proportion of researchers (Baron-Cohen, 1995) while Specific Language Impairment is a linguistic deficit that has at the core of its diagnostic criteria the intactness of other cognitive skills, among them theory of mind (Leonard, 1998).

5.7.1. Shared Attention Mechanisms (SAM)

According to Baron-Cohen (2005) this system, which develops at around 14 months of age, creates triadic representations by determining if the self and another agent perceive the same event (thus triadic, involving two communicators and an object of attention). It is more complex than a dyadic relationship, because it can not only represent what another agent perceives or desires (Mum sees the teddy-bear or Mum wants the Teddy bear) but it can also represent a third person’s view in an embedded or recursive way (Mum sees that I see the cup). The theory posits that the Shared Attentional Mechanism uses inputs from the Eye Direction Detector and the Intention detector and joins two inputs from these systems using the process of recursion. The onset of this module is marked by the apparition of joint attentional behaviours such as proto-declarative pointing and gaze monitoring.

5.7.2. The emotion Detector (TED)

Baron-Cohen (2005) later revised his 1994 model as he felt that there was a missing affective factor in a model that was only comprised of a Theory of Mind at higher level cognition, lacking emotional input and monitoring. The Emotion Detection module is supposed to fulfil this void in the dyadic level in early cognition and the Empathizing System is the proposed module that run parallel with Theory of Mind manipulating emotion-laden representations. The Emotion Detection module builds on a special kind of dyadic representation detecting affective states of other agents. Evidence supports early representation of emotion in infants, as early as 3 months old (Walker, 1982, as cited by Baron-Cohen, 2005). The emotion Detector is also hypothesized to be amodal, thus being able to represent auditory as well as visual stimuli, thus processing facial expressions as well as changes in intonation and in the case of congenitally blind children the case is often made for tactile information as well. The Emotion Detector was proposed to represent only basic emotions, even though Baron-Cohen
himself emphasizes that the term “basic” can be misleading when talking about emotions (Baron-Cohen et al., 2005). In normal population there is an inevitable emotional reaction to perceived scenes and the model tries to accommodate this in the Emotion Detector Module. This emotional response can be detected very early in infancy, between the ages of 9-14 months. The particular case that called for the introduction of this difference was the clinical condition of psychopathy, a serious developmental disorder that is characterized by an antisocial lifestyle and reckless behaviour as well as some marked personality traits, such as a typical callous, shallow and manipulative behaviour in interpersonal relationships (Mitchell et al., 2002). They are reputed for their over proportionate participation in criminal activity, with the typical cases being either serial killers or confidence tricksters. The roots of their criminality are often cited to be utter lack of loyalty, and they remain completely unperturbed if confronted with their own destructive and antisocial actions. Experimental data support this by providing evidence on the lack of fear conditioning, and startle reflex priming, both referring to situations when there is a warning about a frightening or noxious stimuli coming.

In normal population there is a fear response to the warning or conditioned signal even before the onset of the actual harmful or frightening stimulus (Levenston et al. 2000). An ongoing debate has flourished about the exact deficit in emotional functioning, positing underlying phenomena such as deficits in systems mediating fear, response modulation, general affective functioning and most important of all from our point of view, empathy (Mitchell et al. 2002).

Psychopaths are supposed to be very good at theory of mind (this allows them to tricking others into doing things profitable to them), however they clearly lack emotional responses to events (whereby they would not be able to cheat others, because of compassion). The lack of emotional response in psychopaths was likewise proven in the Iowa Gambling Task as well, as task in which participants have to choose between four packs of cards for monetary reinforcement, two of the packs with smaller rewards and smaller losses and on the whole profitable, while the other pack operates with greater sums of won money, but with occasional severe losses that on the whole run outweigh the gains (Mitchell et al, 2002). Patients diagnosed with psychopathy (and those with orbitofrontal lesions) clearly lacked fearful responses to taking risks in losing money and persisted in drawing cards from the riskier and non-profitable deck. The explanation of the phenomena was originally inspired by Damasio’s somatic marker hypothesis, which emphasized the importance of a risk-detection fear system, rather than on emotion detection (Damasio, 1994). However some studies failed to find such a relationship and revealed the importance of anxiety in the task (Schmitt et al, 1999).

Neurologically bad performance in the task were associated with decreased amygdale responses (which is a structure that responds to emotional stimuli commonly associated with fear or sadness responses)(Blair et al., 1999) or decreased OFC (Orbito-frontal cortex) functioning, which is often associated with inhibition of emotional responses (Damasio, 1994). Problems with inhibition in general are indicated by studies requiring reversal response tasks as well, where responses have to be altered to be exactly the opposite midway through the task (Mitchell et al. 2002). The amygdale in recent research however, is more associated with a fear circuitry, than with emotion detection in general (Loughead et al. 2008), which can accommodate the empathy theory less easily.

Regardless of the exact nature of the explanation, the role of lack of empathy stands well established in the literature, even in the lack of differences in intelligence. Psychopathy also tends to be a continous and graded trait rather than a category (Mahmut et al., 2008), thus allowing for the same gradedness as empathy (or in this case, lack of empathy) does as proposed by Baron-Cohen, 2005. It is also of interest to note that psychopathy – as well as a high level of systemizing – is hypothesized to be tightly linked to testosterone hormone levels (Honk et al. 2004) as healthy participants tended to choose more high-risk level card decks after having been administered testosterone. However, these results are interpreted using a
different framework, which operates with an increased need for rewards and a reduced aversion to punishment with higher levels of testosterone. It has to be noted also that this was an experiment manipulating levels of testosterone in adult population whereby the major structures of the brain are already developed and are relatively resistant to change, while the theory of Baron-Cohen (2003) usually refers to the role of testosterone in the course of brain development, mainly foetal development.

5.8. **Theory of mind (TOM)**

Theory of mind is supposed to be the most complex part of the empathizing module, which is also indicated by the fact that this is the ability that takes the longest to develop fully (Baron-Cohen, 2005). This is due to the fact that it involves epistemic mental states to be represented, in other words it allows explicit knowledge about the mental states of others. It has the supposed role of integrate emotions alongside with a range of mental states as well into a concise theory about other’s minds. There are various indicators of the onset of the development of a theory of mind, among others the appearance of pretence play, understanding of false belief and the development of the seeing-leads-to-knowing principle. The lack of either the Shared Attention Mechanism or the Intention Detector on which this faculty is built, presents a serious peril to its development, however not an inevitable one as congenitally blind children seem to develop theory of mind relying on the shared attentional mechanisms (available for them in the auditory or tactile domains) compensating relatively well for the lack of visual Eye Detection Mechanisms (Baron-Cohen, 2005). Children with autism seem to show a delay in the transition from a dyadic representation to a triadic one, as they present a close-to-normal development in the development of intention detection and eye-direction detection, but show a delay in Shared Attentional Mechanisms and they often lack altogether the faculty of a Theory of Mind.

5.9. **Mentalizing skills deficits and language acquisition deficits**

Retarded linguistic skills in all areas of language in autistic spectrum disorders (not only pragmatics, but syntax and semantics have also been shown to be affected) has supported this view, however even in cases of severe autistic traits children are able to speak even more than one language and indeed language functions are highly variable (Groen et al, 2008). One particular case that is often cited is that of an individual named Christopher (Tsimpli & Smith, 1998), who shows some, but not all characteristics of autism, and his obsessive behaviour revolves around second language learning, making him a polyglot savant. However his knowledge is not flawless, not even in his native language, English. His inadequacies are not only apparent in the field of pragmatics as would be expected, but also in areas of syntax and in what was termed as a language faculty by Chomsky himself (1995). While his shortcomings in the area of pragmatics (such as the ability to disambiguate sentences or assigning referents) can be explained by a putative lack of theory of mind, his problems with interpreting syntactically complex embedded sentences and garden-path type sentences defy this explanation. They also pose a problem to the systemizing based explanation of language, as being in the autistic spectrum he would be expected to be a good systemizer, and should grammar depend on this faculty he should excel in the area. Tsimpli & Smith (1998) provide an alternative explanation for his low performance in this task, namely that of problems in short term working memory. His vocabulary on the other hand is impressing, and keeping in mind that vocabulary is reported to be correlated with Working Memory capacity
(Gathercole&Thorn, 1998), there is a slight contradiction in the results. His performance in theory of mind tasks shows an irregularly variant pattern, he seems to be able to assume different perspectives from his own, however he does not perform well on false belief tasks. Therefore it can be assumed that he has at least some difficulty of theory of mind functioning, yet he does speak not only one but various languages. His case also entails a further supposition, that of syntactical knowledge not being conscious and therefore pertaining not to the are of systemizing but rather to that of implicit knowledge.

On the other hand, children affected by Specific Language Impairment (SLI) have not been shown to have a flawed performance on theory of mind tasks, unless of course the tasks are verbal (Miller, 2001). Though there is an intricate relationship between theory of mind tasks and language (as we shall see below) it still seems that theory of mind in itself can not be the answer, yet it seems to have a defining role.

Despite the dissociations described above, it is undeniable that correlation exist between Verbal Mental Age and passing Theory of Mind tasks (Happé, 1995), however this is often restricted to cases where the Theory of Mind task is verbal, such as the case of a classical Sally-Anne task. The task has a non-verbal version, which is reported to lack this correlation with Verbal Mental Age.

5.10. Evidence for higher empathizing abilities in women

5.11. Sharing and turn taking

Girls seem to be more apt in certain communicative and cooperative situations as they show more concern for fairness when sharing valuable goods among themselves, be it sweets or the amount of time spent playing with a particular toy (Baron-Cohen, 2003). Boys on the other hand tend to be more competitive in this sense, unlikely to bother about taking turns when presented with a desirable toy.

5.12. Playing styles

Part of the reason why toddler girls and boys separate into two distinct groups is because their style of playing is very different from each other (Baron-Cohen, 2003). While boys seem to like games that are in close connection to both physical force and assymetrical outcomes (one of the parties winning) this leads them to play games involving mock fighting or wrestling, probing the bodily strength of others. This is not directly connected to their higher systemizing, but rather to their lower scores in empathizing that allows this kind of slightly offensive behaviour.

Girls on the other hand seem to enjoy pretence play much more (Baron-Cohen, 2003), thus games where they can take up different roles trying themselves out in various social situations.

5.13. Sympathetic response to the distress of others

Very early in the development of toddlers they show a sex difference between their reaction to the distress of others. Girls at the age of 1 seem to show greater concern through more sad looks, more sympathetic vocalizations and even more comforting. This difference remains to
be seen in adulthood as well, as more women report to share the distress of their friends, and they report to be more distressed in reaction to the discomfort of others. Their comforting behaviour is not limited to their relatives and friends, as they readily comfort strangers as well, in a much higher proportion than men do.

5.14. **Theory of mind and its precursors**

Girls seem to be interested more in people than boys from the first day of their lives. Baron Cohen and his colleagues (as described in Baron-Cohen, 2003) conducted a study at a maternal hospital in Cambridge, where they presented newborn babies with two possible stimuli. One was a mechanical device, similar to a face and possessing all major contours of the face, but moving in a completely mechanical way. The other stimulus was a real face, which was moving naturally in accordance with general regularities of biological motion. Measuring looking times at these stimuli it turned out that baby boys preferred to look at the mechanic toy face, while baby girls preferred the real, living human face. Although there seem to be no differences between some early components of theory of mind, such as intention detection and gaze direction detection, there is a marked difference in the recognition of emotions (although this is more often associated with the empathizing system, rather than Theory of Mind), where girls seem to excel.

5.15. **Recognition of emotion**

Women are better at recognizing emotions both from facial expressions and from vocalization. They are generally better at picking up non-verbal cues in communication, creating a more detailed and reliable judgement on the partner’s character.

5.16. **Questionnaires measuring empathizing**

Baron-Cohen and colleagues have developed their own questionnaire of empathy as they felt that existing measures were multi-component and did not measure empathy in the same sense that their theory described it. Therefore they created a 60 item long questionnaire, where 40 questions referred to measures associated with empathy, such as willingness to participate in communicative situations and understanding emotional states and beliefs of others.

5.17. **Values in relationships versus dominance hierarchy**

In accordance with the fact of being more cooperative as toddlers, women also value more reciprocal or even altruistic relationships, in short relationships that require a large amount of empathizing. Men on the other hand seem to prefer to participate more in competitive relationships, leading them to struggles of power and finally to the heart of politics. If asked to order the importance of intimacy and that of establishment of dominance, the sexes show different patterns, girls valuing intimacy more while boys being more attracted to the establishment of a hierarchy and social status seems to play an important part in their judgements.

Boys are much faster in developing a dominance hierarchy as well, which is in part explained by their greater need of systemizing relationships and see clearly relationships of power, and
on the other hand it indicates their reduced empathizing skills as dominance hierarchies are often formed on a basis of tears and pain involving pushing others around to become a leader.

5.18. Disorders of empathy

Baron-Cohen (2003) suggests that psychological disorders such as psychopathic personality disorder and conduct disorder can be traced back to a disturbance in the empathizing system, with autism resulting from the disruption of Theory of Mind. While it is true that more men suffer from all of the disorders mentioned above, other psychiatric disorders seem to have an unequal distribution among men and women as well, with women outweighing men among the patients. Depression and anxiety disorders are one of the most salient examples of these (Taylor et al. 2008, for depression Marcus et al. 2008, Bekker & van Mens-Verhulst, 2007), although whether a relationship between empathizing and these disorders exists has not been clearly stated by Baron-Cohen. Taylor et al. (2008) also point out that based on evidence of anxiety scores collected from monozygotic and dizygotic twins the difference between anxiety measures in women is more related to genetic factors than environmental ones, a correlation not present in males, where environmental factors seem to dominate. As anxiety springs on the soil of different concerns, with one of the major components being social concerns (the other factors being physical and cognitive) it can be argued that at least some forms of anxiety disorders, social anxiety disorders can be linked to an overfunctioning empathizing system. Nevertheless, Baron-Cohen (2003) mentions other candidates for an excessive theory of mind, though he is sceptical of both Williams syndrome and people with delusions of paranormal communicative beliefs. However both of these symptoms are characterized by a rather inaccurate perception of other’s minds, thus unlikely to be the consequence of over-empathizing. His final conclusion is that overproportionate empathising skills pose so little disturbance to adaptation to society and general functioning that they are unlikely to fulfil the criteria for qualifying as any mental disorder.

5.19. Aggression

From a very early age boys show reputedly greater levels of physical aggression than girls as already present in their afore-mentioned play-styles. Aggression is made possible by low empathizing skills (though this is based on a rather hedonistic conception of human nature and with the disregard of the possibility of masochistic behaviour, yet probably valid across the board). Baron-Cohen posits that the difference between direct aggression and indirect aggression is characteristic of male and female behaviour and this is also linked to empathizing and systemizing. Men are characterized by direct aggression that is to say aggression expressed mostly by physical forms and obvious both to the sufferer and to outsiders, and according to Baron-Cohen (2003) this requires that one have an even lower empathy than in the case of indirect aggression. Indirect aggression is a subtle way of causing damage, often involving methods that make it impossible to discern who the author of the damage was, and these include gossiping or bitchy remarks. Exclusion is also a possibility, though this is easier to note. Women use this kind of aggression because of two distinct reasons according to Baron- Cohen (2003), one of them is that it allows for higher empathy levels and the second is that it often renders good mind-reading skills necessary as well as the use of language. The fact that indirect aggression is also more strategic is mentioned as well, however it is dubious whether this should strengthen or weaken the argument as strategies are more likely to be associated with manipulative behaviour and has a mental association to
politics, war and even chess, both being male dominated areas. Undoubtedly though, mindreading abilities are indispensable, the debate would be rather on how rule governed gossip was—probably less so than chess is, but military strategies are less obviously absolute rule-bound and are clearly dominated by men.

5.20. **Murder and violent crime**

In psychological literature few things have been less questioned than the fact that violent crime is dominated by men in all societies. The seminal study of Daly and Wilson (1988, cited in Wilson and Daly, 1999) has presented ample evidence on the distribution of murder and the far-reaching superiority of murders committed by men, they estimate that the number of male-on-male lethal aggression is 30-40 times more frequent than that of female-on-female.

5.21. **Linguistic abilities**

According to Baron-Cohen (2003) girls often turn out to be better in verbal skills than boys (though for evidence to the contrary see the section on intelligence and systemizing), an observation based on the theory that they start to talk earlier and they develop faster in both their vocabulary, their grammatical skills and their pragmatic competence, maintaining a stable difference up to adult age.

Wallentin (2008) however in is critical review of the literature concludes that there are actually no overall differences in proficiency in language skills between the sexes. According to his description these sexual differences are often taken for granted and are in fact unwarranted, and in spite of this appear in various textbooks (including Pinker, 2007) and even research papers on the topic of sexual differences, the most often cited differences being on verbal fluency, articulation rate and grammatical skills (as measured by performance: they tend to use longer and more complex sentences). Even though differences between the sexes in the lateralization for language are frequently cited, as Wallentin (2008) points out many studies using neuroimaging techniques such as PET and fMRI include both sexes and often fail to distinguish between them, either suggesting the unimportance of the subject or confounding results. Looking at meta-analysis of various studies the picture is not at all clear about differences in linguistic ability. A meta-analysis using various sources of linguistic measurements, such as vocabulary tests, anagrams, reading comprehension, essay writing reported that while 24% of the studies indeed supports the superiority of females, 66% of them failed to find a difference and 7% even reported males to be superior in language skills. Based on a purely statistical consideration as most studies are operating on a significance level of $p=0.05$, studies where male superiority has been found might be discounted as necessary statistical error, however the vast body of research indicating the lack of difference must not be overlooked. Hyde and Lynn (1988) in their meta-analysis finally conclude that if gender differences indeed do exist they are definitely so small that “it can effectively be considered to be zero” (Hyde and Lynn, 1988, p.64). A piquant detail of the studies on the research for gender differences in linguistic skills is that the first author of the studies had a significant effect on the results found: papers whose first author was a woman reported linguistic ability differences significantly more often than those conducted by men. The most frequently cited evidence on the difference in verbal skills was based on fluency data. Two types of fluency tasks are used widely. In a categorical fluency tasks participants have to name as many members of a given category as they can (most often animals, but sometimes
the category of furniture or tools is applied). In lexical fluency tasks participants have to say as many words as they can starting with a given letter. A research with an impressive number of over 1300 participants failed to find any difference in wither of the fluency measures between the sexes. Results in the experiments depended heavily on the other hand on educational level and age (Wallentin, 2008).

One of the few areas where relative superiority in females could be established is first language acquisition however even this result is only stable in the first two years of life (Wallentin, 2008) as measured by a parent administered vocabulary and grammar checklist, called the MacArthur-Bates Communicative development Inventories. The difference was shown in various languages other than English as well, such as Swedish (all cited examples in Wallentin 2008 being Indoeuropean languages) it is however bafflingly small and it seems to disappear by the sixth year of life (Bornstein et al. 2004). Although in line with at least in part with the theory of Baron-Cohen, it must not go unnoticed that in the first years of life there is a general, non-language specific difference between the sexes, as demonstrated on various non-verbal tasks as well (Galsworthy et al. 2000), which is usually interpreted as a speedier development of girls in the first years of life.

Verbal learning also repeatedly presents a female superiority as measured by the California Verbal Learning Test, where the results seem to be stable across all ages. Higher scores can not be attributed to a general linguistic superiority though, as measures of vocabulary often even show a male advantage. Nevertheless the same test also shows that females have a different strategy to recall words than men do, as they seem to rely more heavily on semantic organization. This raises the possibility that the difference is not due to any linguistic ability but to a different learning strategy in this particular task.

Another long-held supposition has been on the case of language being more lateralized in men and being more distributed across the hemispheres in women. Again, a meta-analysis of studies on lateralization differences based on both behavioral and neuroimaging measures are controversial, most failing to show a sex difference, although the few that do indeed indicate that women are less lateralized (Wallentin, 2008). Neuroimaging studies with few participants seem to report sex differences more often than do studies with a bigger number of participants. As Wallentin (2008) points out however, neuroimaging results are prone to a much larger number of errors due to the influence of such minor nuances as the amount of caffeine taken, involuntary or uncontrolled movements during the test, respiration or cardiac pulsation. Therefore it is only safe to take studies working with a large sample to be reliable which are in turn rare because of the costs of the paradigm. Another line of lateralization studies is based on acquired language disorders or artificially evoked language malfunctions. The fact that linguistic skills in women recover faster after suffering from unilateral strokes, but the Copenhagen study, comprising more than 1000 people has failed to provide sufficient evidence on sex differences in recovery (Wallentin, 2008). On the other hand, a difference was found between the ratio of men and women affected by aphasia during a left-hemishpere stroke and women were found to be affected less often.

Voxel-based morphometry measures, which measure the size of the brain in vivo with the possibility to separate grey matter from other tissue and cerebral fluids have likewise contradictory results when it comes to gender differences. Differences between the size of some language-related areas, such as the inferior frontal (Broca’s) and posterior temporal (commonly mentioned as Wernicke’s area) cortex have been occasionally reported, however they are not consistent across age span nor across studies (Walletin, 2008). The reason that this is due to a life-time change has been suggested, but it does not seem to be able to explain the overall pattern of results, as not all studies find sex and age interactions. The size of the corpus callosum has also been a candidate for difference between men and women, that would explain a faster communication of the two hemispheres as this structure is one of the main
connections between them. However, the evidence has only supported some morphological differences between the shape of a part of the corpus callosum (the splenium in particular) between the sexes (Wallentin, 2008). Voxel-based morphometry also indicates that both of the sexes seem to present a leftwards asymmetry and no sex differences in this respect, thus women being equally left-dominant to men.

Some developmental language dysfunctions are characteristically male dominant, such as stuttering, dyslexia. Other psychopathologic conditions are reported to show a different proportion between the sexes and they are sometimes related to differences in linguistic abilities, such as autism and schizophrenia (Wallentin, 2008).

Stuttering, the frequent interruption or block occurring in transitions between two subsequent sounds is clearly a male-dominant impairment, however it is often accompanied by abnormal facial movements, unrelated to linguistic functioning. Taken into account that stuttering has also been associated with the disruption of ganglio-thalamocortical motor circuits the supposition that it is a dominantly linguistic disorder can be discarded. Dyslexia, reading difficulty without language impairment is also more common in boys. The key however lies in the same definition of dyslexia, that rules out individuals with an underlying linguistic deficit, while the status of reading as a linguistic faculty can be debated because of its (evolutionarily speaking) recent appearance in history.

Schizophrenia is not a primary linguistic deficit and it in fact does not present an overall difference between men and women, however there is a difference in the onset of the disorder (men seem to present the first symptoms earlier) and also in the dominating pattern of symptoms (men present more negative symptoms while women seem to be affected more on the affective side). However, linguistic deficits have not been reliably been shown (Wallentin, 2008). Autism, though clearly related to linguistic difficulties (as language retardation is a diagnostic category) is far more common in males, however the explanation putting forward deficiencies in theory of mind and the disruption of mentalizing causing language disorders are more credible to Wallentin (2008). This theory of mind deficit hypothesis can explain the occasionally surfacing surprising strengths in the area. However, this also implies that there is at least some causal relationship between theory of mind and linguistic abilities and this might be extended to second language acquisition as well. Nevertheless, an explanation based on the “willingness to communicate” would also stand ground. Asperger Syndrome children, whose diagnostic criteria include everything but language retardation, also show difficulties in theory of mind tasks, though not as severely as autistic children do (Baron-Cohen, 2003).

Brain structure differences between men and women

A series of voxel-based morphometric studies reliably identified one area in the brain called the anterior cingulate (or in some studies the cingulated region in general) that present difference between the sexes (Wallentin, 2008). This region is often associated with mind-reading of mentalizing abilities (Frith&Frith, 2006), although concerning this area they emphasize its role in indicating future events, while they claim the prefrontal cortex to be the most important structure in mentalizing abilities.

Language style

Bosacki (2000) has found in a sample of preadolescent students that as assessed by an interview girls were superior to boys in both self-understanding and social understanding, which she interpreted as an evidence to a superiority in theory of mind abilities.
5.22. The evolution of empathising

A female brain built on empathising has the distinct advantage of being firmly woven into the social fabric and therefore individuals with this type of brain would be endowed with much social support. However the most prototypical example is not usually friendship, but mothering as babies and caretaking are clearly tasks that are taken up by women in most societies and it is indisputable that this activity clearly requires empathy. Thwarting aggression is not the sole reason for it, as making sense of another human being, particularly one without the ability to communicate verbally does require a good sense of perceiving and attributing mental states to others. In evolutionary theory there have been attempts to link parental investment to skills in empathy (de Waal, 2005, 2001), to minimize loss because of premature death of infants. One example Baron-Cohen cites is that of checking if the water level does not reach the infants face when crossing rivers, which is not present in chimpanzees, potentially resulting in the death of offspring.

Gossip is mentioned as one of the advantages, although it is not at all clear how Baron-Cohen ties up gossip with survival: the suggested link is being able to find out who is trustworthy and who is not, via gathering social information. This is plausible, however some studies suggest that generally it is primarily negative gossip that is spread on therefore supporting rather who is not trustworthy rather than who is, although trying to predict someone’s next move would definitely be easier if well informed about many aspects of behaviour. Gossip however can be conceived of as another aspect of solidifying social relationships in a group and reducing the level of aggression surfacing at the social network level, a theory posited by Robin Dunbar (1998). He proposes that language is another, more effective kind of grooming, developed by the *homo sapiens* because of the oversized groups they lived in. His theory points out that there is a remarkable association between the size of the brain (as a proportion of body mass) and the size of the groups primates live in. However, group size is also predicted by the time spent grooming, and indispensable tool for reducing aggression in a group. Judging by the brain of the *homo sapiens*, they are supposed to live in groups of approximately 200 individuals, however this would require far more grooming time than can actually be advocated to this activity, as time is needed for feeding, rest and reproduction, which limits the maximum time spent grooming at around 45-50%, a percentage far surpassed by humans. As Dunbar suggests, the solution lies in language, which is a useful tool for grooming via the special possibility on gossip.

5.23. The relationship between theory of mind and other cognitive areas

5.24. First language acquisition and theory of mind

Fodor (1983) and other enthusiastic advocates of modular theory maintain that theory of mind does not in fact contribute the development of language as these are two different modules. In their view language is a mental organ, hard-wired into the brain and it is completely independent from other cognitive-social domains. However earlier theories, Piaget (1962) and Vygotsky (1962) both proposed that language emerges from nonverbal cognitive and social development.

There are striking similarities between first-language learning and the development of theory of mind (Leslie et al. 2005). Both have an early onset, developing at an amazing pace even in cases of mild mental retardation. Also, both of them seems to be modules in the Fodorian sense as there are deficits where a seemingly selective impairment can be observed that prevents the capacity from developing, even in spite of intact mental abilities in other domains.
(autism occurring in case of a defective theory of mind module (Baron-Cohen et al., 1985) and SLI – Specific Language Impairment – is a supposed result of damage to the language faculty (Bishop, 1992; Leonard, 1998)). These similarities have earned both of these abilities the label of domain specific learning mechanisms, that Chomsky posited about language earlier (1957).

In the literature concerning first language acquisition it has become increasingly popular to invoke theory of mind as an explanatory force behind a plethora of linguistic phenomena when explaining shortcomings in performance aimed to test mental grammar (de Villiers, 2007). Undeniably linguistic development unfolds in parallel with the development of theory of mind, however it is essential to discount the effect of general cognitive development.

The direction of causation is less clear-cut than established relationship. Theories that claim that the driving force is language often refer to the role that mental state causal talk plays in the development of theory of mind (i.e. mothers explaining events by what one wants or desires). Although a plausible explanation, children seem to have a definite idea about the goals of agents long before they show any signs of understanding language (Gergely & Csibra, 2003).

Vocabulary learning is often associated with theory of mind, because of the necessity to find the referents of words in the environment. Bloom and Markson (1998) enumerate three distinct mechanisms that are necessary in successful word learning, conceptual constraints about the environment and the surrounding world, appreciation of syntactic cues to word learning and the ability to infer the referential intentions of others. Children can infer various meanings from context that seem to be based on the assumption that the interlocutor is an intentional agent. Classic word learning studies mention this ability as a kind of fast-mapping, however they do not usually point out the role that intentionality plays in these experiments. Two classical examples of the task (as described in Bloom and Markson, 1998) require children to find out the meaning of new words, without actually having a concrete reference to them. They are shown two objects, for example a blue and an olive one and are told to bring the experimenter “the chromium tray – not the blue, the chromium one”. Children correctly infer that the speaker will want the olive tray and they have an astounding capacity to remember words learned this way. In real world situation however objects are rarely pointed at and this kind of exclusionary explanation is not the most frequent. Bloom and Markson (1998) assume that this is done via “attending to the referential focus of the speaker, using cues such as direction of gaze” (p. 69). This in earlier terms would be the same mechanism as shared attention mechanism, which is responsible for joint attention. Children automatically assume that if the experimenter wanted them to focus on an object or a property that was known to them, he or she would have used the name they already knew, which actually assumes a rather complicated theory of mind. In theory one could suppose that this had nothing to do with theory of mind, but it is rather the result of a logical conclusion from the premises that (1) all objects have different names and (2) the first object was called x, so this one has to be called y. The reason to suppose nevertheless that this fact is more related to social interaction than to formal laws of logic is because children tend to use it when hearing new facts about objects as well (for example if told that “my aunt gave this to me” and asked for the object “dogs like to play with”) they tend to form the hypothesis that the two facts referred to two distinct objects. The supposed underlying mechanism lies in an innate knowledge about social interactions, and children’s reactions are interpreted so that if the experimenter had wanted to refer to the first object, he or she would not have used a different fact to refer to it. Adults are usually worse in remembering this kind of information and as second language acquisition data show they have particular difficulties in learning morphology and syntax.
Some researchers argue that the independence of theory of mind from the development of language is due to the fact that to that it is related to social interaction in general, while language has other prerequisites as well and only plays a certain role in social interactions (Meins & Fernihough, 1999). This line of research draws the attention to the interdependence of social environment and the ability to mentalize, such as the treatment of children by their mothers as intentional agents. Meins (1997) has suggested the explanatory frame of maternal mind-mindedness (treating the child as an entity that has a mind) to explain the development of theory of mind, which refers to “mothers proclivity to treat their child as an individual with mind from an early age” (Meins & Fernihough, 1999, p. 364). The research has suggested a relationship between linguistic acquisition style (Meins & Fernihough, 1999), but supporting facts are weak with no detectable differences between children with high mind-minded mothers and low ones in common-noun vocabulary. The lack of results might be due to the small number of participants that the authors explain by the attrition in numbers during the 4 years of the experiment. The situation was further exacerbated by the sample size being reduced to 8 children due to their failure to produce the minimum number of common words in the task, as at 3 years of age their production vocabulary has not reached a high level. Another result that proved to be significant indicated that there was no relationship between manifestations of theory of mind at 3 years old and children’s early vocabulary content. This would suggest that theory of mind is neither a prerequisite for nor determinant in first language acquisition, at least as far as vocabulary acquisition is concerned.

Perner et al. (1994) also argue that though theory of mind develops on a basis that does not require language, its speed of development depends on the ‘database’ available on mentalizing experience, however they base this supposition not on parent-child interaction, but rather on interaction between siblings, showing that children growing up in bigger families seem to develop a theory of mind earlier than those living in small families.

Other studies have demonstrated that vocabulary by preadolescent age does show to be related to theory of mind as measured by non-standard interviews that assessed both social understanding and self-understanding (Bosacki, 2000).

A special subset of linguistic abilities, namely that of mentalistic language has been shown to have a close relationship with theory of mind (Gottfried & Jow, 2003). Data based on spontaneous use of subjective feeling states shows that children are able to express both their subjective feelings and their desires as early as the age of 2. Spontaneous conversations are also used as a source for information on children’s development of understanding of others’ beliefs, intentions, desires and emotional states, in short, what is normally termed as theory of mind. The understanding of both one’s own emotional states and that of others develops on the ground of talking these states over with others and research has shown that there is a reliable correlation between the amount of mentalistic words children use and their performance in theory of mind tasks, such as false-belief (Gottfried & Jow, 2003). In addition, not only conversations but also children’s books and fairy tales are a rich source of mentalistic language as there are plenty of references to thoughts and feelings in children’s stories. In many narratives, the structure depends heavily on recognizing the characters thoughts, feelings and desires, over and above the use of mentalistic language.

One of the presumed sub-systems of theory of mind, imitation has been proven to be an extremely useful tool in language learning as Meltzoff’s Active Intermodal Mapping (1999) has shown there is an inborn capacity to map sounds onto lip movements. In his experiments 18 and 20 week old infants were given a simple lip-reading task with a preferential looking paradigm. Infants were shown two faces, one articulating the sound /a/ the other the sound /i/ in perfect synchrony. A loudspeaker was placed between the faces and one of the sounds (/a/or /i/) were played, while the faces remained in the sight of infants for 2 minutes and the length of their looking at each picture was measured. The results showed that children looked
at the face making the sound they have heard from the loudspeaker longer. Meltzoff has also shown (1999) that infants are also shown to imitate sounds they hear from a very early age, as young as 12 weeks old, if their vocalizations are analyzed phonetically and with a speech spectrograph as well. Meltzoff (1999) maintains that infants do not live in a blooming buzzing confusion without much cognitive structure and with seriously impoverished input, which would entail the necessity of much inbuilt knowledge and would be a strong reason for modularity. Instead she emphasizes that actually infants are placed in a highly organized psychological world and they are armed to fight cognitive difficulties with various tools, such as imitation, cross-modal mapping and a primitive grasp of theory of mind.

5.25. Teaching and theory of mind

The interrelation of teaching and learning and theory of mind is very intricate. Humans seem to be particularly inclined to engage in teaching and learning (Tomasello & Call, 1997) and both these activities are thought to be centred around Theory of mind. Tomasello goes even as far as to argue that theory of mind is a prerequisite of any form of teaching (Tomasello, 1999) and his argument is not unwarranted if we take into consideration that according to the observation of Wellmann learning is passing from ignorance to knowledge and from false belief and misconception to more accurate belief (Wellman&Lagatutta, 2004, p. 480). In order to want to change the beliefs of someone it is essential that one be convinced about the existence of beliefs. It is therefore clear that Theory of Mind abilities are indispensable in the teaching profession. In fact, it has long been recognized in psychology how much teacher’s conceptions and misconceptions about children and the teaching process influence the outcome of the process. The effect has come to achieve fame under the name of Rosenthal-effect, as it has been introduced by Robert Rosenthal as interpersonal expectancies (e. g. Rosenthal, 2002). The effect works merely because educators have a theory of mind and beliefs about the thoughts, desires and knowledge of their students and consequently to this an expectation about how well they would perform in different situations. Taking a solely cognitive point of view however, we can conclude that a good theory of mind would help teachers identify problems in understanding the subject or the question argued about.

Another intricate issue to mention is the relationship between the reception (as opposed to exertion) of teaching and theory of mind, which relationship can be exceptionally important when studying foreign languages.

5.26. Learning and theory of mind

The experiments that are discussed in this chapter are based on the tests that were developed by Baron-Cohen (2003) to measure empathising and systemizing. Essentially four tests have been used that were all translations of the author: (1) Reading the mind in the eyes test, (2) The Faces test, (3) The systemizing Quotient test, (4) The Empathising Quotient test.

6. Experiments

Validating of the Reading in the Eyes test – Hungarian version
Empathising and systemizing as predictors of subject preference and university course

Empathizing in teachers as an indicator of their success

6.1. Independence in learning versus social learning and results on the RMET test

Simple questionnaire on lang exam results and the proportion of time spent studying independent, classroom or private teacher. Natives not considered.

6.2. Relationship between grammar task based and communicative style teaching and empathizing and systemizing

Following an earlier supposition that empathising-oriented students would be more motivated by communicative teaching style and would profit more by this kind of teaching, I formed the hypothesis, that dividing a group of students into successful and non-successful learners based on their exams in a Language Exam preparation course would reveal that students who were successful are likely to have been taught with a method that corresponded to their preferred learning style.

Participants
A total of 54 students participated in the study from the Department of Budapest University of Economics and technology, taking a one-semester course preparing for an intermediate exam in English (Origo – Hungarian Language Assessment Board, Állami Nyelvvizsgabizottság (ANyB)). The details of their data is presented below. They were approached via teachers of the university and were asked to fill in the questionnaires on a voluntary basis on their last lesson. Instead of names codes were used, which were the e-mail addresses of students. The e-mails were necessary to be able to contact them later to find out about their detailed exam results. Out of 54 people 43 answered the e-mail and provided the answers on their exam results. Teachers were also asked to give information on the results of each student on the test. Test scores were however a single number without specification to what areas the student be better or worse in.

Procedure

Students were administered the Reading the Mind in the Eyes Test and the Systemizing Quotient Questionnaire, and a further question that referred to the teaching style of the teacher during the course. The question asked students to describe the percentage of time they spent solving grammatical tasks, closed end questions and written work (Language centered groups) and on the other hand the time they spent communicating freely or semi-freely in class (Communication-Centered groups). 3 months later they were sent an e-mail asking for their exam results. Some students did not get the exam by that time, they were contacted 3 months later. Teachers were asked to give information on the semester-final test results of students.

Results
Factor analysis for groups

Correlation of semester end tasks and questionnaires

Correlation of specific points in exam results and questionnaires

6.3. **Empathizing and systemizing in the language learner – individual differences in success at language learning**