Journal of Personal Selling & Sales Management

ISSN: 0885-3134 (Print) 1557-7813 (Online) Journal homepage: https://www.tandfonline.com/loi/rpss20

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**To cite this article:** Willem J.M.I. Verbeke & Jolly Masih (2020) Evolutionary-shaped goal orientation in *Homo sapiens*: how life sciences contribute to a better understanding of salespeople as knowledge brokers, Journal of Personal Selling & Sales Management, 40:1, 43-56, DOI: 10.1080/08853134.2019.1654389

**To link to this article:** https://doi.org/10.1080/08853134.2019.1654389



Published online: 28 Oct 2019.

JOURNAL OF PERSONAL SELLING & SALES MANAGEMENT
2020, VOL. 40, NO. 1, 43–56
https://doi.org/10.1080/08853134.2019.1654389



# Evolutionary-shaped goal orientation in *Homo sapiens*: how life sciences contribute to a better understanding of salespeople as knowledge brokers

Willem J.M.I. Verbeke and Jolly Masih

Erasmus University Rotterdam, Burgemeester Oudlaan 50, Rotterdam, 3000 DR, The Netherlands

**ABSTRACT**

Life sciences uses the Latin name *Homo sapiens* to describe humans, an animal species. First, we discuss how "popular beliefs" about the brain have inhibited the progress of life science applications in the field of selling. Subsequently, we present the Tinbergen's evolutionary perspective of life sciences and use "ultimate" and "proximate" explanations to understand the salesperson's main goal of becoming a knowledge broker. First, an ultimate explanation describes how the *Homo sapiens* evolved to acquire a big brain through natural selection processes, which led to the emergence of multiple cultures. This evoked a runaway selection of genes affecting brain functioning called "cultural drive hypothesis." The big brain shapes people's goal orientation and leads to better cooperation and exact copying of knowledge. Both are constitutive for the exponential emergence of innovations within and across cultures through multiple generations. Second, the proximate view explains how, for example, neural-endocrine mechanisms modulate knowledge brokering. We explore five hard-wired processes associated with a salesperson's skill in knowledge brokering, applying factual insights obtained from neuroscience, endocrinology, and genetics. Finally, we outline different strategies that researchers who seek to make new contributions to the field can undertake in doing research on selling.

**ARTICLE HISTORY**
Received 6 February 2019
Accepted 7 August 2019

**KEYWORDS**
knowledge brokering; life sciences; popular beliefs; Tinbergen perspective; ultimate and proximate explanations; social learning

> Humans' success is sometimes accredited to our cleverness, but culture is actually what makes us smart. (Laland 2018a, 7)

There is growing interest in the application of life sciences, specifically neuroscience, endocrinology, and genetics, in the field of selling (e.g., Dietvorst et al. 2009; Bagozzi et al. 2012). These researchers in selling are using neuroscience (e.g., computational neuroscience, evolutionary biology, and basic neuroscience) and biomarkers extracted from human tissue and biological samples (e.g., blood, hair, brain matter, and saliva) and applying advanced life science technology to measure brain volume, brain connectivity, blood cell count, or endocrine secretion levels. These measures are blended with other traditional research methods, including questionnaires or field experiments, to understand certain phenomena, such as motivation, sales performance, and customer awareness. For an overview of the technical terms used in this paper, the reader can consult the terms in Table 1.

In this article, we provide an overview of the life sciences–based research that is conducted with respect to selling, with the aim to motivate further life sciences–based research in this field and provide something for researchers to learn from and explore. First, we briefly introduce the essential sales practices of "knowledge brokering." Then we discuss naïve or simplistic views on how researchers have sought to undertake a life sciences approach and explain why they inhibit progress in applying life sciences to selling. We contrast that with the "Tinbergen evolutionary perspective" (Tinbergen 1963) on life sciences, and we argue that these insights can enrich the field of selling. Conjecturing that goal orientation is an important evolutionary conserved mechanism that allows all species to survive, we present the "cultural drive" hypothesis to explain how the human brain developed into a proficient goal striver, allowing efficient cooperation with conspecifics, copying knowledge more efficiently and with much higher fidelity than other species, and transferring knowledge through learning to subsequent generations (culture). Then we describe five "hard-wired mechanisms" shaped by evolution that modulate human "goal-orientation processes" associated with knowledge brokering and social learning, using insights gained from our studies in genetics, endocrinology, and electroencephalography (EEG). We will argue that gaining knowledge based on insights and research methods from life sciences allows researchers to gain new insights that in turn have practical applications for sales managers. We subsequently outline concrete steps for researchers in the field of selling to undertake such research endeavors and arrange them according to how difficult they would be to implement strategically.

**CONTACT** Willem J.M.I. Verbeke verbeke@ese.eur.nl

## Salespeople as knowledge brokers in an ecosystem or industry

We have entered a knowledge-based economy. As proposed by Paul Romer, 2018 Nobel Prize winner in economics, knowledge is an endogenous part of our economy (Romer 1985). Economic actors (such as business owners and employees) are purposely transforming advances in knowledge, such as scientific inventions, and adopting or emulating new technologies, transforming them into concrete applications that allow countries and industries to grow, exponentially, across generations (Romer 1985). This adoption of innovations is conceived in life sciences as "social learning," which is a process that contributes to the transmission or diffusion of ideas in industry (Kendal et al. 2018; Nonaka, Toyama, and Konno 2000). In their recent publication, Hartmann, Wieland, and Vargo (2018) present a similar perspective on selling, as they propose that salespeople's activities within their firms are embedded in ever-evolving industries or ecosystems that operate like institutions that develop and endorse cognitive frames, values, and rules. Examples within the sales domain include the adoption of sales-force automation applications, such as Salesforce.com, which operate within software platforms used by firms worldwide (e.g., Marshall et al. 2012). Another example is one whereby salespeople offer customers new solutions that are being created by their firms (e.g., cars) that conform to the evolving technological standards of the industry in which they are embedded (e.g., selling electric cars as opposed to cars that run on gasoline) (Agnihotri, et al. 2014). Other examples include sharing narratives, in person or via LinkedIn, about trends and developments within the industry (e.g., about sustainability or climate change) and how the solutions offered fit these developments (Hartmann, Wieland, and Vargo 2018). In addition, salespeople are being trained in selling techniques, such as solution-based selling, that are well crafted scripts used by many firms and that improve the performance of a salesperson in terms of final sales (e.g., Rapp et al. 2014). On the basis of such adoptions of knowledge-based solutions, the sales force learns to operate in more efficient and effective ways, thus aligning with and helping to shape the trends in the industry in which they operate, which, in the end, allows them to add value for their customers (Hartmann, Wieland, and Vargo 2018).

We propose that, within an industry or ecosystem (Hartmann, Wieland, and Vargo 2018), the main goal of a salesperson is to operate as a knowledge broker (Verbeke, Dietz, and Verwaal 2011). Knowledge brokers aim to have constructive conversations with customers and other stakeholders that are characterized by psychological safety to identify their customers' problems and issues or to detect new trends and opportunities in the industry (also known as competitive intelligence) (Hughes, Le Bon, and Rapp 2013). In many cases and in collaboration with colleagues, they will then brainstorm on the ideas originating from these interactions with customers and stakeholders to reach practical solutions (Goad and Jaramillo 2014). Knowledge brokers codify these insights around the practical solutions or products into language (verbal or mathematic), learn to structure their conversations using sales techniques, such as SPIN selling, or build persuasive narratives about how their firm's solution is in line with the technological trends in their industry (e.g., Hughes, Le Bon, and Rapp 2013; Agnihotri et al. 2014). Note that all salespeople, irrespective of whether they engage in transactional, relational, or solution selling, are knowledge brokers, as certain components of knowledge brokering, such as using sales techniques, sharing knowledge about products, sharing narratives, or inferring goals from the customer, are among their daily activities (e.g., Hughes, Le Bon, and Rapp 2013, 93; Agnihotri et al. 2014). Also note that social learning is the core characteristic of knowledge brokering.

## Naïve views about life sciences in applying life sciences to the field of selling

In this article, we distinguish two popular beliefs or types of folk wisdom that act as cognitive biases, blinding the believers from appraising the true value of life sciences in the field of selling. The first bias comes from using psychological concepts as metaphors to model the brain in the form of dualism. This metaphorical thinking has its roots in the philosophy of Schopenhauer (1873) and the psychoanalytic theory as first laid out by Freud (2014), which drew a distinction between the conscious and unconscious minds. Typical examples of dualism are "thinking fast and slow" (Kahneman and Egan 2011) and "conscious versus unconscious" processes (Bargh 2011). Such outside-in metaphors are frequently exemplified by visualizations, such as the "iceberg principle," which reinforces the attraction of the popular belief that dramatically oversimplifies the life sciences approach. The visible part of the iceberg is supposed to represent the conscious brain and the part underwater the unconscious brain.

The second popular belief has to do with the "reverse inference" problem, where researchers wrongly believe that a specific neural mechanism or biomarker serves as a specific behavioral function or correlates with a specific phenotype (Poldrack and Yarkoni 2016). An example is the belief that oxytocin is the "love or social hormone," an inference that is not scientifically substantiated, as one recent meta-study shows (Bakermans-Kranenburg and van IJzendoorn 2014). In addition, it is imprecise, as the hormone oxytocin is also associated with feelings of fury among out-groups (De Dreu et al. 2010).

The brain, however, does not operate the way folk wisdom generally thinks it does (e.g., in terms of causality – if you do X then Y will follow). Rather, it operates as a complex system that emerges from co-activation of biological units on several different levels, such as genes, neurons, and neural networks, the latter of which unite in convergence zones and, from there, co-activate other neural pathways to give rise to what people experience as meaningful or worthy (Cacioppo et al. 2000). As Cacioppo et al. (2000) note, two principles play a key role: "multiple determinism" and "reciprocal determinism."

Verbeke and Bagozzi (2014, 117) described these two principles as follows:

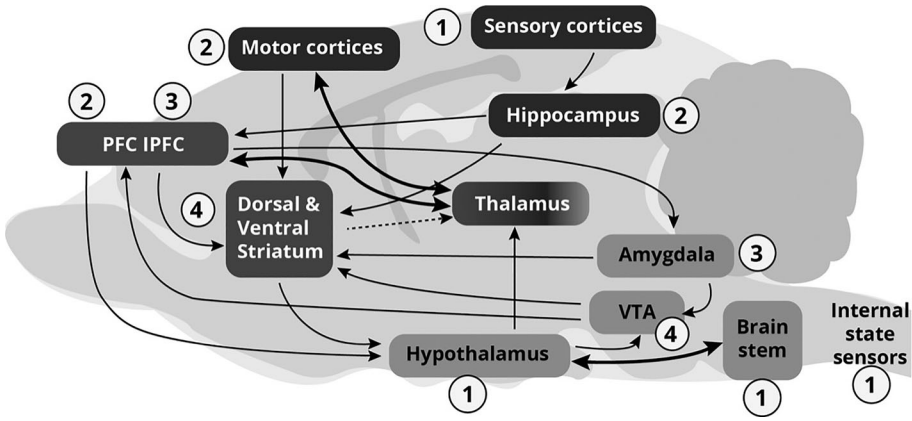


Figure 1. A neuroscientific presentation of goal orientation (adapted from Verschure, Pennartz, and Pezzulo 2014). Note: Figure 1 was not built on reverse inference but conceives brain regions via their co-activations as connected to one another, giving rise to emergent goal-oriented behaviors in both humans and other vertebrates. Also note that this brain depicted in Figure 1 is not a human brain but one that is most similar to that of all other vertebrates, such as rats, whose prefrontal cortex is smaller compared to that of humans. © 2014. Paul F.M.J. Verschure, Cyriel M.A. Pennartz, and Giovanni Pezzulo. All Rights Reserved. Reproduced with permission.

> The principle of multiple determinism maintains that any behavior at one level of organization can have multiple antecedents within or across levels of organization. This implies also that any behavioral phenomenon at one level of organization can function to explain another variable at the same level or across levels … The principle of reciprocal determinism asserts that mutual influence can occur between biological and social variables to determine behavior. This typically occurs recursively, rather than simultaneously, such as might happen when social variables influence psychological variables through their effects on neural, hormonal, and/or genetic variables.

## Taking the Tinbergen approach of life sciences to selling

A useful life sciences approach to study sales processes is that based on the "Tinbergen perspective" of evolution. The Tinbergen perspective entails two explanations: "ultimate" and "proximate" (e.g., de Waal and Preston 2017; Bateson and Laland 2013). The first explanation maintains that, to understand specific behaviors of a certain species (and here the species of interest is that of the *Homo sapiens),* researchers need to think in terms of the adaptive significance and evolutionary history of that species. The second explanation focuses, in terms of causation and mechanisms, on ontogeny or acquisition of the behavior of members of that species (Ryan and Wilczyński 2011). Next we explain both of the Tinbergen explanations as they are used throughout the article. First, we focus on the ultimate explanation, while discussing the big brain hypothesis, and subsequently **we** focus on proximal explanations, discussing five studies that have been undertaken in selling.

### *Ultimate explanations of the evolution of the big brain in* Homo sapiens

In general, there are two main schools of thought around the ultimate explanations and the emergence of the *Homo sapiens*. Some researchers suggest that *Homo sapiens* differ substantially from any other species, especially the great apes, because, compared to all other species, only humans can occupy and adapt to almost every condition or territory in the world. The cultural drive hypothesis emphasizes this difference between the *Homo sapiens* and other species (Laland 2018a; Tomasello 2010). Laland seeks to extend the Darwinian natural selection theory by calling his work *Darwin's Unfinished Symphony* (2018a). Other researchers focus on similarities between *Homo sapiens* and other species, especially researchers working in the fields of biology (Wilson 1999) and evolutionary psychology, a popular area of marketing research (e.g., Griskevicius and Kenrick 2013). We address the similarities between *Homo sapiens* and other species, followed by the differences.

*Goal orientation is what Homo sapiens shares with other species*: Goal orientation is a vital process shared by all vertebrates, including mammals, birds, amphibians, fishes, and reptiles. In psychology, whether animal or human, goal orientation has been studied from the perspective of the "hierarchy of basic needs" (Maslow 1943) and the "expectancy valence" theory (a conscious process) (Vroom 1964). The premise of this article, however, is that life sciences (neuroscience, specifically) allow us to better understand goal orientation. Two important aspects of goal orientation need mentioning. First, in fundamental physiological terms, goal orientation originates in the homeostatic processes. Homeostasis is the tendency of a physiological system to maintain internal stability (e.g., both activation and ending of neural pathways unfold at set points). Second, as in "cybernetics" (which explores regulatory systems in monolithic systems; Ashby 1961), the goal is not defined a priori but instead is a multidimensional process that emerges from interactions across a number of perceptual, affective, cognitive, and motor systems, which in turn interact with the environment. In this section, we explain the goal-directed choice model by Verschure, Pennartz, and Pezzulo (2014) and define multidimensional, emergent, goal orientation as the ability to integrate the crucial questions why, where, what, when, and how (see Figure 1[1], which presents a simplified version of the model).

*Why (1)*: Physiological drives, such as thirst, hunger, sleep, status, and safety, originate in homeostatic processes involving sensor effector and actuator systems in the

hypothalamus and the brainstem. The hypothalamus is a key center for homeostatic processes. In neurological terms, "drives" emerge from a gap between a readout of a homeostatic parameter (e.g., sodium levels in the body) and an optimal set point (e.g., thirst) that evokes a particular need (e.g., drink when thirsty).

*Where, what, and when (2)*: When an animal commits to satisfying a specific need, the intensity of information processing triggers a search for goal-predictive input that might help it to attain its goal (such as water when it feels thirsty). Here, both hippocampal and prefrontal systems are crucially involved in creating state presentations that allow action selection to take place in the motor cortices. As Verschure, Pennartz, and Pezzulo (2014, 7) explain, " … w*hen* the needs of an agent have been set at a level of the hypothalamus, representations of the state of the world are required to determine *where* and *when* this need is satisfied and through which object or state (*what*)."

*How (3):* The prefrontal cortex, especially the lateral prefrontal cortex, is concerned with "task and action-space" representations. The task and action space is known as a set of rules, goals, and goal-predictive values (Verschure, Pennartz, and Pezzulo 2014) that are needed for using tools, solving concrete problems, and making choices. In addition, the amygdala plays a key role in determining affective value. It is, thus, responsible for affective-driven goal-oriented behavior.

*Learning (4)*: An essential aspect of goal orientation is learning to optimize the why, where, what, when, and how questions. The striatum plays a key role in this process. Its main mechanism is involved in goal prediction – envisaging what the outcome could be when deciding what action to take in pursuit of a particular goal. Drawing on this feedback mechanism, future goals and what it will take to attain them can be tweaked. This also requires that striatum activation synchronize with other cortical regions, such as the anterior cingulate and orbitofrontal cortex (part of the prefrontal cortex).

All of these interacting processes need integration to form a coherent or holistic system so that goal-directed processes can be generated and implemented. Since the *Homo sapiens* have a much larger prefrontal cortex than other species, they have the ability to integrate these goal orientation processes into projects that require "mind traveling." Specifically for this article, mind traveling reflects the career goals of the knowledge broker (Suddendorf 2013). Within this perspective, there is also the observation that humans have a notion of "self in the sense of representing the subjective, first-person process of self as observer and knower of one's own actions and history, and feelings and meanings attached to these" (Bagozzi and Lee 2019, 299).

*A bigger brain is what makes* Homo sapiens *different from other species:* There is plenty of scientific evidence that the unique species *Homo sapiens* is capable of innovation, or in terms of this article of engaging in knowledge brokering. Reader and Laland (2002) studied the degree to which 116 of the 203 known primate species possess greater cognitive ability or intelligence, gauged by various measures, such as behavioral innovation, social learning, tool use, and social behavior. They found that brain size represents executive brain volume, which they perceived as the cerebral cortex – the largest part of the cortex, reflecting the outer layer of the cerebrum (consisting of six layers) and the striatum (part of the "limbic system") – which is known to be involved in learning. Both brain nuclei sizes (cerebrum and striatum) correlated well with cognitive ability across species (See Figure 2). Reader and Laland (2002) coined the term "big brains," meaning that greater brain sizes come with greater innovation abilities due to the larger central executive brain regions.

Given that humans develop complex cultures, including the creative arts and scientific theories and inventions, businesspeople are fully capable of copying and improving innovations, an incremental process that ultimately led to exponential growth in cultures. Indeed, Laland (2018a,b) argued that purposively efficient, high fidelity copying plays a key role in distinguishing *Homo sapiens* from other species. All vertebrates can copy and develop culture (think of birdsong), but their bigger brain allows humans to copy more effectively and to greater purpose. As Laland (2018a, 7) concretely described it: "natural selection does not favor more and more social learning but rather a tendency towards better and *better social learning*. Animals do not need a big brain to copy, but they need a big brain to copy well."

In turn, innovation affects the natural selection process; for example, instead of remaining dependent on hunting, humans invested time in growing foods. The cultural drive hypothesis suggests that natural selection favors intelligence, specifically anatomical structures or functional capabilities that promote efficient copying, such as inheritable traits that help the next generation to survive, and this results in the runaway process of genes that are associated with specific traits. Examples include the forkhead box P2 (*FOXP2*) gene (which is involved in using language), the notch homolog 2 n-terminal-like (*NOTCH2NL*) gene (involved in neural growth), and the ɤ-aminobutyric acid A receptor (*GABRA4*) gene (involved in inhibitory functioning between neurons) (see Staes et al. 2018; Laland, Odling-Smee, and Myles 2010).

Traits that are transmitted polygenetically (meaning those that are associated with many genes) allow the emergence of complex cultural behavior. For example, better visual perception enables humans to copy others over greater distances and imitate fine motor movements. It fosters greater connections between perceptual and motor structures in the brain, helping individuals to copy someone performing a skill by moving their own body in a corresponding way. It also enhances perspective-taking and theory of mind (ToM), which allow people to cooperate (Tomasello 2010). In addition, the connectivity between prefrontal cortex and limbic system is stronger, leading to greater self-regulation (Baumeister and Tierney 2012). Note how this description of the big brain mirrors knowledge brokering (of salespeople) in which social learning is a key component as is discussed in the earlier chapter.

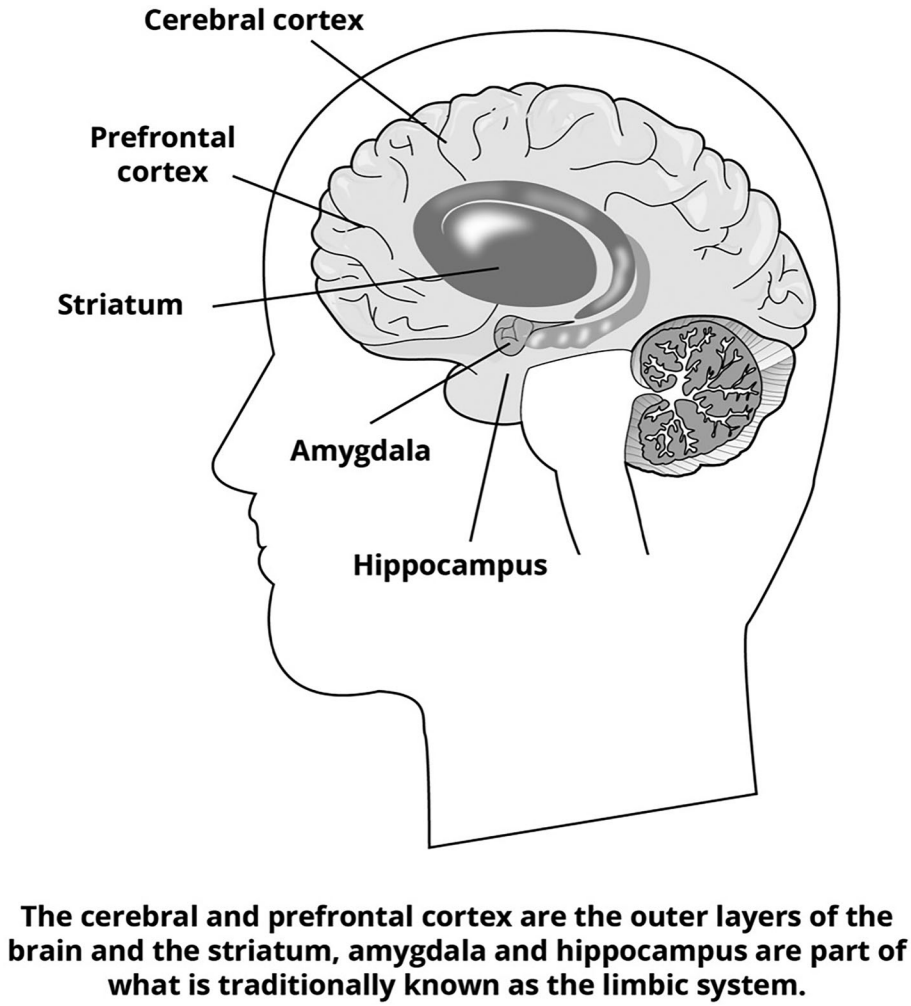


**Figure 2.** The brain of the *Homo sapiens*.

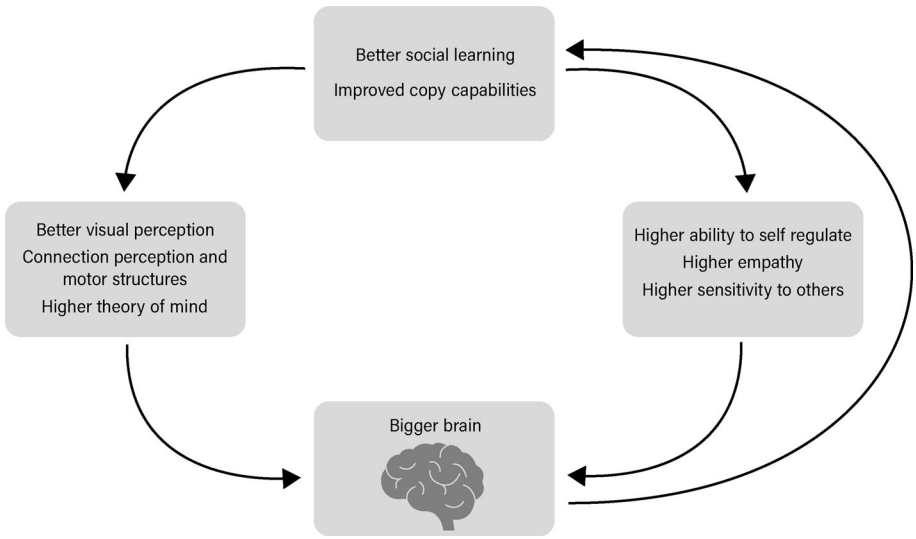


**Figure 3.** The cultural drive hypothesis according to Laland (adapted from Laland 2018b).

So the cultural drive hypothesis brings benefits (see Figure 3): a better perspective comes with higher empathy and sensitivity to others, and a better diet comes from the development of agricultural technology. However, it also has its downside. Compared to other species, humans have an extended infancy. Juveniles need to spend a long time in training, and learning continues throughout their lifetime. Learning is thus mainly a social phenomenon, meaning that

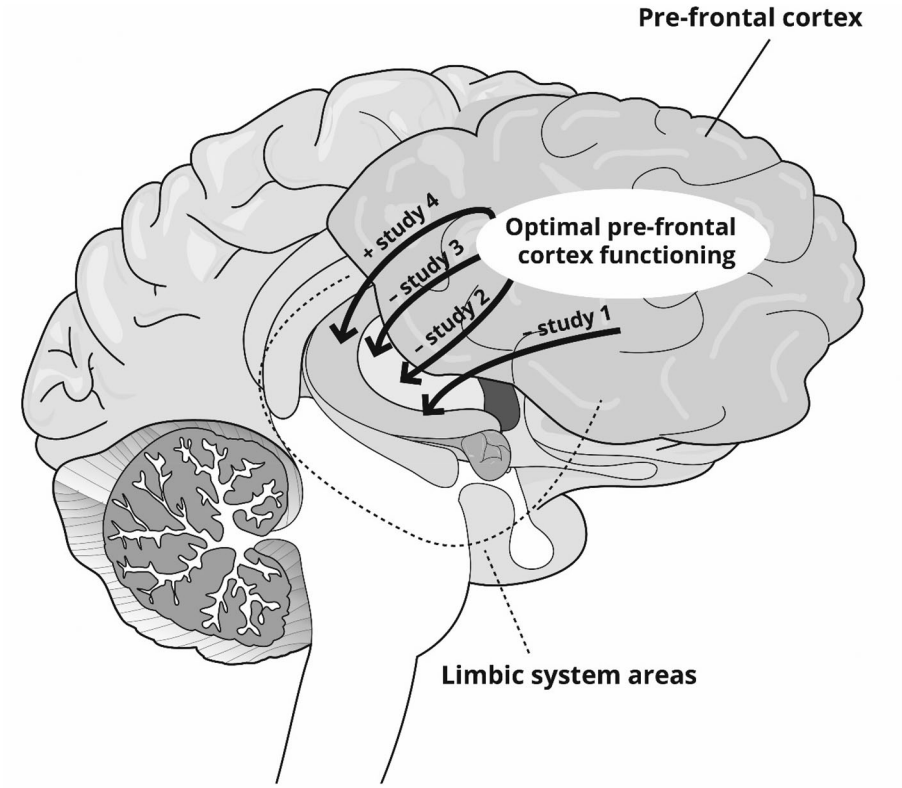


**Figure 4.** Prefrontal regulation studied in the first four proximate studies.

to function well in the cultural niche (field or industry), individuals need to copy others to learn how to behave acceptably. As before, we find these key aspects essential for engaging in knowledge brokering.

### *Proximate explanations of the brain's main function: engaging in goal orientation*

In our study, while seeking proximate explanations, we adopted various techniques from the life sciences – ranging from basic neuroscience and molecular genetics to endocrinology and dual EEG – to measure biomarkers embedded in various hard-wired biological and brain systems at various levels of analysis (e.g., Lee, Senior, and Butler 2012). Here, we present five different studies.

## Study 1: Competitiveness during contests

Sales managers frequently use sales contests in their organizations to invigorate the performance of their salespeople (e.g., Lim, Ahearne, and Ham 2009). In this study, we investigated how business students engaged in the well-known sales management game by Patton (1994) (Verbeke et al. 2015). To win, teams had to devise better sales strategies than their opponents (innovation). Teams also could buy management reports to study the game strategies of opponents (social learning). Winning a contest normally comes with a spike in testosterone levels (Archer 2006). The study wanted to find out whether the members of the winning team attained the highest testosterone levels.

Speaking proximately, challenges trigger the release of testosterone by an evolutionary hard-wired system, namely the "hypothalamic–pituitary–gonadal axis." This system facilitates synthesis of this steroid hormone in the gonads – the ovaries of females and Leydig cells in the testes of males – as well as in the adrenal cortex of both males and females (Eisenegger, Haushofer, and Fehr 2011). An important effect of a rise in testosterone levels is that it negatively affects the connectivity between brain regions, the prefrontal cortex, and limbic nuclei – which include the amygdala and nucleus accumbens, both of which are densely populated with testosterone receptors (see Figure 4). Lower connectivity between prefrontal cortex and limbic system lowers people's ability to self-regulate and makes them more impulsive and hence also more assertive and even more innovative.

The researchers in this study explored two hypotheses: first, they assumed that people with high pre-game testosterone levels, indicating eagerness to win and self-confidence, would have higher testosterone levels if they won. This is known as the challenge hypothesis (Archer 2006). Managers sometimes call them "winners," which shows up in their "competitive" body language. Second, the researchers expected to see differences in testosterone levels between contest winners due to individual differences in the genetic

make-up of team members. Taking a candidate gene approach, they focused on a single nucleotide polymorphism (SNP) of the dopamine receptor gene (*DRD4*) and the Catechol-O-methyltransferase (*COMT*) gene. Widely expressed in the prefrontal cortex, these two genes are known to affect self-regulation and task planning (see the section on goal orientation). Specifically, the carriers of *DRD4* $7R^+$ compared to the carriers of *DRD4* $7R^-$ and *COMT* $Val^+$ compared to Met/Met are known to be less efficient at self-regulation, in general, and thus in these contests they behave impulsively. Therefore, the researchers expected that these people would show higher testosterone levels after they had won a contest. The results of the study generally substantiated these two hypotheses.

What can be learned from this study? Sales managers organize sales contests to raise the performance of salespeople and to energize their sales teams around company goals. Indeed, the data show that contests energize the participants, biologically speaking (due to production of testosterone), yet this happens in different ways as the production of testosterone levels operates according to the principles of multiple determinism (Cacioppo et al. 2000). There are people who become excited merely from participating in a contest and become even more exuberant when winning. Other people also show exuberance due to a lower ability to self-regulate, which is due to their genetic make-up making them behave more impulsively, so to speak. Other salespeople do not show much biological excitement when winning, which is also due to their genetic make-up.

## Study 2: Sales presentation anxiety

Salespeople often experience "sales call anxiety" (Verbeke and Bagozzi 2000). The researchers in this study studied a similar concept – "sales presentation anxiety" – during an executive account management course where participants needed to present sales pitches to customers (played by the other course participants), thus exposing themselves to criticism and ridicule (Verbeke et al. 2016). Making account pitches is a core task of a knowledge broker (see earlier sections). Managers would often like to understand why some of their salespeople suffer from stress more than others.

When people are put under stress – like the participants in this study – the body has to prepare itself to deal with the stressors. It must respond quickly but then be able to relax again when the threat is gone (LeDoux 1998). The stress or anxiety system, thus, functions like a homeostatic system. Many people believe that, when people feel stress or anxiety, their cortisol levels rise.

Speaking proximately, how do higher cortisol levels affect the functioning of the brain? First, social stress activates the amygdala (which is sensitive to threatening stimuli), and this triggers the hypothalamic–pituitary–adrenal axis (a hard-wired system shaped through evolution), which stimulates both the hypothalamus to produce corticotrophin-releasing hormone and the pituitary gland to produce adrenocorticotropin hormone. These hormones make the adrenal cortex produce cortisol, which causes the prefrontal cortex to become less efficient in its goal-achieving role (Arnsten 2009) (see Figure 4).

As with the sales management game, the researchers asked: "Would the participant's genetic make-up affect his or her cortisol levels during the sales presentation?" People with high cortisol levels more frequently show this in their body language, such as when a speaker's hands start trembling and he or she stumbles over the words. This study tested the participants' genetic make-up with two candidate genes: the *DRD4* gene mentioned previously and dopamine receptor D2 (*DRD2*) gene polymorphisms.

According to the differential susceptibility hypothesis (Belsky, Bakermans-Kranenburg, and van IJzendoorn 2007) and the reciprocal determinism principle (Cacioppo et al. 2000), being a carrier of one gene variant can be beneficial in one environment but not in another. Therefore, the researchers conjectured that carriers of the *DRD4* $7R^+$ or *DRD2* Taq $A1^+$ variants are easily distracted and will focus less on their own anxious feelings. Hence, they would have lower cortisol levels during the presentation. In fact, lower cortisol levels were found in the presenters who were carriers of both *DRD4* $7R^+$ and *DRD2* Taq $A1^+$ variants.

What can be learned from this study? An important task of sales managers is coaching their salespeople about how to interact with customers or how to handle difficult situations (e.g., Shannahan, Bush, and Shannahan 2013). Sales managers must seek to understand why some salespeople become stressed more than others and their voices choke during their presentation, while others do not suffer from this type of stress. Although holding a presentation is almost always stressful, this study shows that salespeople's genetic make-up affects their way of coping with that stress. This insight allows managers to develop tailor-made coaching methods when coaching salespeople on sales call anxiety.

## Study 3: Knowledge brokering by observing from customers

Managers frequently notice that some salespeople prefer not to develop strong relationships, but rather appear to behave more like hunters and have a more diverse customer portfolio or social network, which allows them to socially learn from a heterogeneous set of customers. Therefore, we studied how salespeople build social relationships that are influenced by attachment styles.

An important hard-wired evolutionary mechanism that is common among mammals has come to be known as the "attachment system." Researchers noticed that human beings are "born with an innate homeostatic system that motivates them to seek proximity to significant affective others (attachment figures) in times of need, as a way of protecting themselves from threats and alleviating distress" (Ein-Dor et al. 2010, 124; Bowbly 1969). The way in which caretakers interact with their offspring during the period before adulthood – which takes a relatively long time, as the big brain hypothesis proposes – is assumed to have a lasting or imprinting impact on how adults appraise trustworthiness and form relationships with others (Mikulincer and Shaver

2007).[2] Researchers expected to see lasting effects in a professional selling context, namely, during knowledge brokering by salespeople.

Speaking proximately, the attachment system acts like a goal-directed homeostatic system that allows the child to feel safe and to calm down when it feels under threat or stress. Over time, the process cements into the brain an internal working model of one kind of social learning. The process codes caring behavior by caretakers (via the prefrontal cortex) and allows for mental simulation (ToM network activation) and (via striatal activations) prediction of likely outcomes (the sense of comfort or lack of it). In addition, oxytocin system activation is involved when responding to various types of attachment behavior by caretakers (Vrticka and Vuilleumier 2012, 2). Depending on the child's experience with the care it receives from caretakers, it will develop a certain attachment style, which affects the way its internal working model operates.

The literature distinguishes three main attachment styles: (1) The secure attachment style is regarded as the default attachment system modus (applies to 65% of the population). Securely attached people received consistent and reliable care from their caretakers when they were children, and they were comforted in moments of stress, which taught them to co-regulate. These people experience their social environment as unthreatening (also called a "safe haven"). (2) The anxious attachment style reflects a hyperactivation of the attachment system (applies to 14% of the population), and these people are prone to detect even the slightest threat in their social environment). (3) The avoidant attachment style reflects a deactivation of the attachment system (applies to 21% of the population). Avoidant attached people have learned not to depend on attachment figures in times of need or when under stress. They remain independent and cannot let themselves be soothed by others; hence, they only rely on self-regulation but not on co-regulation.

One of the popular beliefs about attachment styles is that being securely attached is an advantage in a wide variety of societal contexts, as securely attached people are better at developing relationships than those who are insecurely attached (anxious or avoidant); the latter therefore are at a disadvantage. In fact, the study by Verbeke, Bagozzi, and van den Berg (2014) found that, if a salesperson is avoidant attached and a carrier of the *DRD4* $7R^{+}$ (statistically speaking, an interaction effect) he or she tends to engage more in social learning – this was measured using the customer orientation scale (Saxe and Weitz 1982). More specifically, the study conjectured that avoidant attached salespeople have a more diverse customer portfolio or diverse social network and that this is due to their lower prefrontal cortex functioning. This means that these people are more distracted, seek more variety, yet also become more sensitive to incentive salience (i.e., to rewarding cues) (Figure 4).

What can be learned from this study? Managers must understand that their salespeople differ in their social learning style when interacting with customers and that this is due to the biologically programmed attachment system that they developed at a younger age. Here, the avoidant attached salespeople (a substantial share of the sales force) are better at observing customer responses (buying signals) than at empathizing with those customers, as they prefer to remain independent (i.e., they do not crave long-term relationships with customers) and this affects their social learning style. Again, this insight allows managers to adapt their coaching style to these types of salespeople (based on attachment styles).

## Study 4: Knowledge brokering by empathizing

Firms with a strong customer-service ethos hire employees who are able to interact pleasantly and develop relationships with their customers. In this study, researchers were interested in exploring whether evolutionary hard-wired mechanisms related to empathy and compassion would become activated when knowledge brokers would facilitate social learning (gauged by customer orientation) (Verbeke, Bagozzi, and van den Berg 2013). Research shows that the joy people experience when being with other people is due to a hormone called oxytocin, which is produced in the hypothalamus.

Speaking proximately, when people experience feelings of closeness to others, the hypothalamus is activated, which is where the hormone oxytocin is synthesized and released to a range of nuclei in the central nervous system, especially the prefrontal cortex and the limbic system; for the latter, these specifically concern the amygdala and nucleus accumbens. Testosterone weakens the connectivity between the prefrontal cortex and the limbic system, whereas oxytocin produces the opposite effect; depending on context, oxytocin release strengthens connectivity between the prefrontal cortex and the limbic system regions (such as the striatum, hippocampus, and amygdala). These regions are densely populated with oxytocin receptors and, when oxytocin is released, they are known to affect the detection of "social salience," meaning they make the person sensitive to the emotional facial expressions of others (see Figure 4), which in turn triggers social motivation, especially with respect to approaching other people. This motivational state makes a person more empathic, meaning more sensitive and tolerant toward others (Skuse and Gallagher 2009).

Rather than studying the oxytocin levels per se, the researchers were interested in whether salespeople's genetic make-up would also play a role. They focused specifically on the variations or polymorphisms of the oxytocin receptor gene (*OXTR*) and investigated whether this would affect salespeople's social learning (gauged by customer orientation). They particularly explored whether salespeople who were carriers of polymorphisms of the *OXTR* gene, the GG versus GA/AA ($G^{-}$) variants, would engage more in empathizing with customers. Indeed, these types of salespeople were better at knowledge brokering – meaning they would score higher on customer orientation.

What can be learned from this study? Within the field of selling, creating psychological comfort in relation to customers allows these customers to be more receptive to whatever the salesperson is offering (social learning). Furthermore, salespeople with a large degree of empathy achieve more

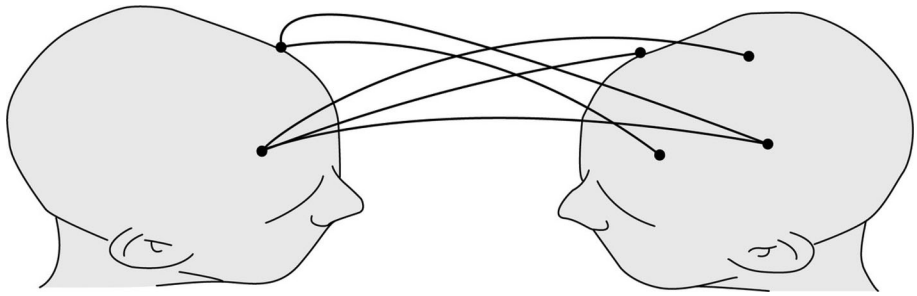

Figure 5. The study on interbrain synchronization.

with less effort. This study shows that some salespeople show more empathy than others due to their genetic make-up, and this also allows them to socially learn from customers. Firms can use this knowledge to develop a hiring policy to suit their business strategy; for example, firms that accentuate customer intimacy should hire salespeople with a large degree of empathy.

## Study 5: Alliance formation and knowledge brokering

A person's ability to forge social alliances involves a reciprocal appraisal of trustworthiness. When a salesperson is forging an alliance with a customer, it is important that both sides trust each other, especially when the financial stakes are high. It ensures that they are able to exchange knowledge comfortably and easily engage in social learning (Morgan and Hunt 1994). Some people believe that a high level of mutual trust reflects a high degree of synchronization between the brains of the two people concerned. This popular belief has its source in the social psychology literature on the synchronization of primitive behaviors, such as mimicking body movements or word imitation (e.g., Bargh 2011).

Sun et al. (2019) used EEG to study interbrain synchronization in the interactions between two actors playing an iterative trust game (Berg, Dickhaut, and McCabe 1995) to discover whether social learning about each other would influence their mutual level of trust. Observing two people interacting on a social task involves measuring the direct activity in both brains simultaneously (Babiloni and Astolfi 2014, 77). Dual EEG or hyperscanning EEG allows for direct observation of the degree of interbrain synchronicity that occurs mainly between the two prefrontal cortices. Speaking proximately, here, the prefrontal region plays an important role in the big brain hypothesis as it is involved in perspective-taking and ToM (Dietvorst et al. 2009).

In the study by Sun et al. (2019), the researchers hypothesized that social learning is affected by two complementary strategic decisions made by both players. The first involves trust as such, defined here as a "willingness to show vulnerability by taking a risk." For the trustor this would mean, for example, believing that the trustee will not take advantage of him or her. The second deliberation involves evaluating the other person's trustworthiness, defined as the willingness of one person (the trustee) to behave well toward the other person (the trustor). The trustee is responsible for consistently signaling that he or she is trustworthy, displaying social intelligence using his or her ToM network, or knowing that receiving endowments comes with a sense of obligation to reciprocate the money invested with him or her. Registering the trustee's positive signals (repayments), the trustor learns to see the trustee through a "lens of trustworthiness" (Hardin 2003).

In terms of framing effects, the trust game was framed as either a "trust game" or a "power game." Researchers hypothesized that players in the "trust game" would show a lower interbrain synchronization than players in the "power game." The reason is that the trustee takes on the highest responsibility in the game, compared to the trustor. In the trust game known as the "power game," both became equally opportunistic and thus showed higher interbrain synchronicity (Figure 5).

What can be learned from this study? Sales managers sometimes train their salespeople to mimic the customer's behavior, as this would meet their intuitive view of trust (popular conception), which suggests that high levels of trust pair with high levels of interbrain synchronicity. This study, however, found the actual opposite to be true: higher trust levels were found to coincide with lower levels of interbrain synchronicity between trustor and trustee playing a high-stakes economic game, as the trustee – whose role can be compared to what a salesperson would do in sales interaction – would take the lead in creating and maintaining a trustworthy relationship, despite short-term potential opportunistic behavior from the buyer (buyer).

## Implications and research directions for researchers

Having reviewed the essential topics from life sciences and having described how five studies exemplified their application to the field of selling, although these are scarce in the sales literature, the subsequent question was how researchers in the field of selling could be motivated to engage in a life sciences approach to selling, followed by the question of whether those researchers could be helped to make significant strides in their research endeavors.

Here, we propose a path of discovery for how to apply life sciences to selling. A path of discovery could begin with an outline of a sales management process model (e.g., recruitment, motivation, work satisfaction, performance) or a sales process model (e.g., visit, conversation, closing, satisfaction, relationship). This could be supplemented with examples of possible questions to ask and how to use life

**Table 1.** List of terms.

| |
|---|
| Brain connectivity: a statistical relationship based on correlational patterns or on causal modeling between different regions of the brain. |
| Candidate gene approach: seeks to find an association between a genetic variation (mostly an SNP) and a phenotype of interest. |
| Convergence zone: nuclei in the brain that receive different projections from other brain nuclei that enable integration of information and, from there, a nucleus projects to other nuclei in the brain, allowing the brain to execute a range of functions. |
| DNA: deoxyribonucleic acid with a sugar and base pairs guanine (G), adenine (A), cytosine (C), and thymine (T), known as the genetic code. On the basis of the base pairs, proteins are produced that produce substances that regulate cellular dynamics that maintain cellular functioning. |
| EEG (electroencephalography): a measure of the electric activity in the brain where it is assumed that specific bands correspond to specific brain activities in that brain region. This technique has a high temporal resolution. |
| Empathy: the ability of a person to feel what another person feels, but not attribute these feelings to himself or herself. |
| Encephalization quotient: the relative brain size measure computed by the ratio between brain mass and the body volume of an animal. |
| Endocrinology: the study of how the chemical messenger "hormone" is secreted by specific organs in body and brain regions and affects the functioning of organs, both in body and brain, which in turn has behavioral effects. |
| fMRI (functional magnetic resonance imaging): the measuring of brain activity on the basis of blood flow. It is assumed that the blood flow to brain nuclei reflects an increase in activity, compared to that in other regions of the brain. |
| Genetics: an important branch of life sciences that deals with a person's genetic make-up that affects how traits emerge in organisms and how these genes are inherited by the subsequent generation. |
| Genome-wide association study (GWAS): seeks to find associations between genetic variations while screening the entire genome with a phenotype of interest. |
| Limbic system: consists of several brain structures placed around the thalamus, including the amygdala, hypothalamus, hippocampus, and cingulate gyrus. It is involved mainly in emotion and motivation. Note that this region is connected to several regions in the neo-cortex. |
| Molecular genetics: the study of how sequences of genes and their variations are transcribed and translated in a cell or neuron and how that affects the cellular functioning of a cell or neuron, which in turn might be related to a trait. |
| Neo-cortex: the outer layer of the brain, made up of 6 layers (I to VI). It is involved in higher-order brain functions especially in cognition, action, social interaction, language, and moral reasoning. |
| Phenotype: the observable traits that an organism possesses in terms of behavior, physical properties (as brain size), or biological processes such as endocrine processes (the latter of which is an endophenotype). |
| Prefrontal cortex: reflects the frontal part of the neo-cortex and is mainly perceived as the orchestrator via executive functioning of goals and actions. In addition, it allows a person to engage in both short- and long-term planning. |
| Single nucleotide polymorphism (SNP): a variation in a genetic sequence that affects variations in the base pairs guanine (G), adenine (A), cytosine (C), and thymine (T) and that occurs in more than 1% of a population and is associated with a phenotype. |
| Social learning: the acquisition of new behaviors via the observation, imitation, or training of behaviors of conspecifics in the social environment. |
| Species: a group of organisms that share common characteristics (genotypes and phenotypes) and that are capable of breeding and producing fertile progenies. |
| Theory of mind: the ability to attribute intentions, needs, beliefs to others and oneself with the awareness that the other person's intentions, needs, beliefs are different from one's own. |

sciences methods to extract biomarkers that will enhance understanding of what it means to be a knowledge broker. Examples of such methods include electroencephalography (EEG), functional magnetic resonance imaging (fMRI), endocrinology, genetics, and epigenetics. These methods are well documented; therefore, we will refrain from describing them here (e.g., see Lee, Senior, and Butler 2012; Senior, Lee, and Butler 2011). The methods described in the following cover various levels of analysis (e.g., molecular, neuronal, pathways), span different spatial (fMRI) or temporal resolutions (EEG), only mention noninvasive methods (e.g., saliva), and do not focus on invasive methods (e.g., blood) (Cacioppo et al. 2000).

The path of discovery that we would like to propose instead focuses on the degree of efficiency or effortlessness by which researchers could apply such methods when considering the use of biomarkers in their research. We assume that researchers in the field of selling would look beyond their own marketing departments (silos) and contribute to setting up interdisciplinary research teams involving members from various life sciences departments. We present some research strategies for researchers to apply in life sciences, but note that the proposed strategies and fields of research are far from exhaustive (see Senior, Lee, and Butler 2011 for a more comprehensive overview).

*Big data and biobanks*: In many countries, large biobanks with biodata have been built. A Dutch example is Lifelines, with a subject pool of around 167,000 people. These institutions take biological samples (e.g., blood) from the people in their subject pool, which allows for the extraction of genetic make-up for research, such as in genome-wide association studies (GWAS), or candidate genes or gauging of endocrine levels, such as testosterone or cortisol levels. Other biodata include anthropometric measurements, such as body weight and length. In addition, subjects complete questionnaires about their personality traits and mental state, such as degree of happiness or feelings of anxiety, and are tested on mental abilities (IQ). They also are interviewed by trained physicians about their mental and physical health. This database is connected to other databases, such as those of Statistics Netherlands (CBS), which include economic data (e.g., income) and data related to employment situation (e.g., job satisfaction). From the Lifelines–CBS interface, the profession of the participants can be identified, which includes salespeople, and this, of course, is the profession of interest for our study. Using traditional statistics or machine learning, it is possible to uncover associations between many variables of interest.

Advantages: This type of approach requires low risk approval by an ethics committee, such as from one's own university, as the data are collected by third parties (e.g., Lifelines and CBS, in the Netherlands) who already are approved by such an ethics committee (i.e., secondary data). The researchers, having paid an entrance fee (estimated at EUR 10,000 per project), just need to ask for the variables of interest from the Lifelines or CBS catalogs, which are then gathered in a designated data file in the cloud, from where they can be extracted by researchers and used for computing the relationships between certain variables of interest. The data sets are large (e.g., data on more than 15,000 participants), which ensures the reliability of the findings and allows for multiple relationships to be studied. Especially for quantitative marketing researchers, this research trajectory is the easiest to follow.

Disadvantages: The data are not company-specific, and most if not all the scales are not specific to the various sales

domains. Although data about income are available, which could be an indicator of the performance of a salesperson, it is difficult if not impossible to link biomarker variables to concrete sales performance or motivation.

Examples of research questions: Do successful salespeople (higher salary) have higher testosterone levels (biomarker)? Do people who work in sales have a different genetic make-up, based on a GWAS approach, compared to people in other professions? Do anxious salespeople have higher cortisol levels (biomarker) and are they less happy (self-report)?

*Field or lab experiments using heart rate and saliva*. Researchers can study behavioral effects in field experiments, such as by changing incentives of a team or changing feedback styles of sales managers in the experimental condition versus control condition. During such experiments, researchers can then request the participating salespeople to donate saliva (e.g., Verbeke et al. 2015). Although field experiments are more ecologically valid and allow for studying large pools of people, they also may contain more errors, whereas lab experiments can be designed for very specific research questions and allow for tight control of the environment but may result in lower ecological validity. In addition, in both field and lab experiments, less-intrusive biomarkers can be used, such as heart rate or eye movements (gauged via eye-tracking). Such measurements can be coupled to questionnaires that, for example, gauge a salesperson's personality traits or mental state. These sources of information all can be used during data analysis to uncover associations or causal relationships.

Advantages: Researchers can use baselines of hormone levels and study the way in which these levels change (increase or decrease) in the experimental condition. In addition, it is possible to focus on endophenotypes, answering questions such as "would genetic variations correlate with changes in hormone levels?" Such multilevel analyses allow for a better understanding of how a salesperson's genetic make-up (lower level of analysis) affects the endocrine outcome (medium level of analysis), which in turn affects the behavioral or performance outcome (higher level of analysis). In addition, experiments allow for replication studies, which are lacking in most of the research in neuroscience or neuromarketing as well as in marketing in general.

Disadvantages: Extracting biomarkers from saliva is very costly; for example, gauging testosterone and cortisol levels at different intervals (time periods) during an experiment costs about EUR 40 per hormone per participant. When applying genetics to the experimental set-up, a large sample size is needed, which in turn makes the experiment more expensive. In addition, firms might not always agree to participate in such studies as the collection of biomarkers would invade the privacy of their employees (representing ethical risks to the firms).

Examples of research subjects: As salespeople are knowledge brokers and may have to hold presentations for their customers, virtual reality (VAR) may be used to study their behavior under threatening conditions (i.e., in front of a nonsupportive audience) versus nonthreatening conditions (i.e., in front of a supportive audience). This would enable studying their eye movements, using the method of eye tracking (which is built into the VAR) to reveal the things that anxious people pay attention to, for example, their observation of the eyes, faces, or body movements of people in their virtual audience. Another possibility is tracking the changes in heart rate (with subjects wearing a heart rate monitor) and cortisol levels (using saliva samples). These different variables, together, increase our ability to study and understand the processes involved in sales presentation and sales call anxiety and allow for therapeutic interventions.

*Administering of hormones in an experimental setting*: The hormones described are produced naturally, but researchers could also orally administer hormones, such as oxytocin or testosterone, to their test subjects and study the causal effects on behavior, cognition, and feelings of the participants (see De Dreu et al. 2010). In social neuroscience, the administering of hormones has in fact become an intense field of research as it enables researchers to study causal relationships between hormone levels and behavior, rather than merely investigating the associations (see Eisenegger, Haushofer, and Fehr 2011). Such studies appear to be lacking in the field of selling, but they could produce insights into how, for example, salespeople as knowledge brokers develop relationships with their customers or why they would display different interaction styles.

Advantages: Administering hormones is easy to implement and enables the study of causal relationships. Researchers can use existing knowledge from neuroscience, or from studies on oxytocin or testosterone administration, and form concrete sales-domain-specific hypotheses about the impact of oxytocin and testosterone and how they affect social interaction. As the effects of hormones are gender-dimorphic, researchers would also gain a better understanding of whether and how male and female knowledge brokers operate differently.

Disadvantages: As oxytocin or testosterone administration takes place in a lab environment, it is difficult to extrapolate insights beyond the lab environment into managerial implications/applications. In addition, administering hormones involves a relatively large degree of risk for the participants and requires stringent ethical commission approval. In addition, extra caution must be taken about receiving the subject's consent for his or her participation in the experiment.

Examples of research questions: As building relationships and having psychologically safe conversations are important aspects of knowledge brokering, oxytocin administration could uncover how psychological safety is achieved between salesperson and customer. During a role-play experiment, for example, oxytocin could be administered to the salesperson but not to the customer (oxytocin condition), versus a control condition. This would enable gauging whether, depending on the experimental condition, higher or lower psychological safety is being felt by the customer. In addition, the salesperson could be asked to report his or her feelings (positive versus negative) about the conversation. In addition, using a similar set-up, one could study whether administering oxytocin would also lower the degree of sales call anxiety felt by the salesperson when interacting with a customer.

*fMRI and EEG*: In the application of life sciences in relation to salespeople, most researchers consider fMRI-based research as the core research method because one of its research outputs (i.e., the pictures of brain activations) is visually very attractive. It is true that, in the big brain hypothesis, the cerebral cortex and limbic system are the key nuclei involved when salespeople engage in knowledge brokering (see earlier sections). Therefore, single-person fMRI (intrabrain activations) should take an important place in the research on selling. Indeed, single-person fMRI studies, even beyond the field of selling, have unraveled the salesperson effect (Falk et al. 2013) and have shown that the activation of the temporal parietal junction (see also Dietvorst et al. 2009) was involved when participants were asked to gather relevant information from a certain video to inform another person about whether the video would be popular to use before an audience (which is akin to knowledge brokering). In addition, single-person fMRI-based research has uncovered that, during the performance of social versus nonsocial tasks, different brain-network activations are being evoked (e.g., Lieberman 2013). However, we do not focus on single-person fMRI- or EEG-based research; instead, we focus on interbrain processes that emerge when people interact; hence, the emphasis is on dual fMRI or dual EEG (this research focus is also suggested by Senior, Lee, and Butler 2011). The reason for this focus is that our brain does not operate in isolation but is made to communicate and engage in social learning. The main question, therefore, is how brain activations reciprocally affect another brain's behavior and how these interpersonal behaviors, in turn, affect the functioning of both brains (reciprocal determinism) (e.g., Lieberman 2013). Hence, we briefly outline this latter development.

*Dual fMRI*: This is a very fruitful approach and will attract much attention because, as we suggested, the baseline of the salesperson is that he or she engages in social learning processes that take place during salesperson–customer interaction. Using dual EEG, it is possible to study how one person responds to another, given their expectations about that particular person (e.g., "will a salesperson answer my question in an intelligent way?"). In an early study, using the iterated trust game, King-Casas et al. (2005) found that, when a trustor in a game received money back from the trustee, his nucleus accumbens became activated. They interpreted this finding to mean that, when the trustor's risk taking was reciprocated by the trustee, the trustor experienced being rewarded.

Advantages: Dual fMRI allows for high spatial resolution and enables researchers to understand when and which brain regions become co-activated, given the dynamics of the social interaction. For example, are there different interbrain co-activations when conversations involve social learning about a specific topic, or would similar brain regions be activated when both participants experience psychological safety?

Disadvantages: Dual fMRI requires many financial and physical resources from the center that organizes the procedure. Creating a connection between the two fMRI scanners is expensive and only few researchers are experienced in this new trend in neuroscience. In addition, note that while the two participants are online connected with one another, they remain physically disconnected and thus are unable to synchronize their facial expressions. However, because salesperson–customer interaction is moving increasingly from face-to-face to online contact, or occurs via mobile phones, this research method has a higher ecological validity than assumed.

Examples of research subjects: Role-play, as it is frequently used in sales training courses, can be studied in a dual fMRI environment; for example, in an experiment, one person plays a salesperson and another person is the customer. Having instructed the salesperson to act friendly in conversation, it could then be studied which of the brain regions are activated in the customer. Here, it is for example also possible to study which brain regions are activated when a customer experiences psychological safety.

*Dual EEG*: Dual EEG, which provides high temporal resolution, has become quite well established in the field of social neuroscience, spurring a wide field of research (e.g., Schilbach 2010). Most studies, however, focus on simple tasks, such as finger tapping, but as we have seen, knowledge brokering is about social learning. During the performance of a social-learning task, Sun et al. (2019) showed that it has become easy to compute, for example, the phase-locking value to gauge the interbrain synchronicity (see Study 5).

Advantages: Most sales interactions take place in face-to-face interaction between salesperson and customer and, thus, include second-to-second co-responses. As dual EEG has a high temporal resolution, this method is very effective in capturing these dynamics. Using well-designed behavioral experiments, it is possible to study the conditions under which interbrain synchronicity occurs and how it relates to specific behaviors and feelings that occur within specific experimental settings.

Disadvantages: EEG lacks spatial resolution; hence, it is at times difficult to interpret the real meaning of the findings, such as on interbrain synchronicity in specific bands covering specific regions of the brain. For example, for a person not familiar with brain science, what does interbrain synchronicity gauged with the phase-locking value of alpha bands in the brain, especially the frontal and central regions, actually mean? Information about the step from laboratory finding to practice might be difficult to find.

Examples of research questions: Would salespeople and customers who work in the same industry (and thus share the same culture) show higher interbrain synchronicity, compared to those who do not? Would salespeople high on the long tail (who thus possess higher expertise) display lower interbrain synchronicity when they interact with customers, compared to those lower on the long tail? Would there be a difference in interbrain synchronicity between when a customer talks to a real salesperson versus to a robot?

## Conclusion

Having provided the reader with insights into what is meant by life sciences and how they can be applied in the field of

selling, we leave it to readers to decide for themselves whether these insights may add to their research practice. It depends on the readers, their risky shift and their level of curiosity whether they are open or closed to this nascent field of the application of life sciences in the field of selling (Cartwright 1973). Moreover, this question can only be answered when researchers apply neuroscience themselves, but here we hope to have guided potential researchers in what would be the easiest step to take and to warn them about the more intellectually challenging steps ahead. For many researchers, doing this kind of research might create parochial fears, while others might be motivated to break through the barriers and collaborate in interdisciplinary ways with colleagues working in different fields of research.

## Notes

1. Note that we do not mention the thalamus in the text, but, as Figure 1 shows, it plays a crucial role as a convergence zone connecting different nuclei in the goal orientation system.
2. The focus of our current research is that these assumed imprinting effects might be due to the fact that early life experiences silence the expression of specific genes needed to homeostatically regulate cortisol levels when the hypothalamic–pituitary–adrenal axis is activated and give rise to higher cortisol levels. Silencing genes is also known as epigenetics.

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