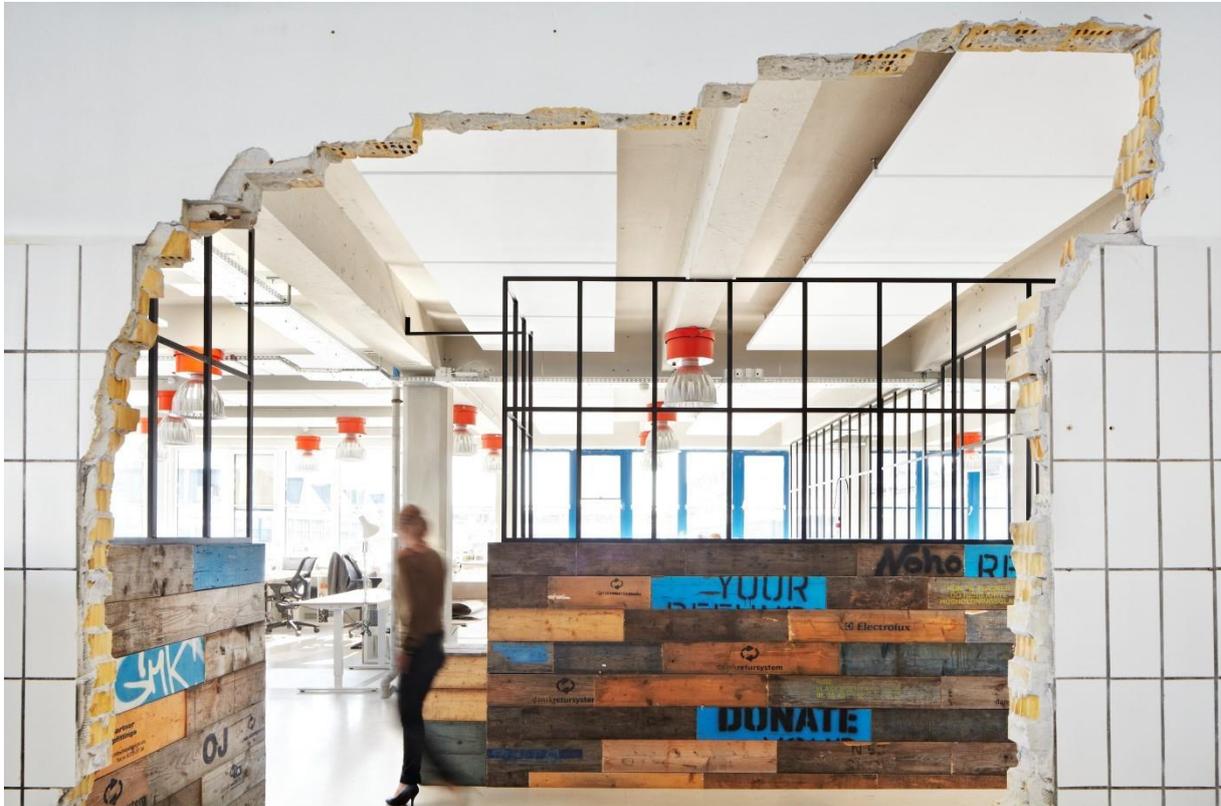


# How to create a brain friendly office? | Sound Design for Brain & Cognition



This whitepaper is created by Saint-Gobain Ecophon.

Author: Yvette Tietema

13-09-2017, Etten-Leur

**Contents**

- 1. Introduction..... 3
- 2. Our brain at work ..... 3
  - 2.1 Conscious and subconscious input that affect concentration ..... 3
  - 2.2 Three brain systems ..... 4
- 3. Distractions in the open office space ..... 5
  - 3.1 Designing for quantity and quality ..... 5
  - 3.2 Room acoustics..... 5
  - 3.3 Personal characteristics..... 6
  - 3.3 Acoustical etiquette ..... 6
- 4. Psychoacoustic measurement tool ..... 7
- 5. Wrap up..... 8
- Bibliography..... 10

## 1. Introduction

Due to advanced technology and automation, jobs are disappearing, but also new jobs are being created. For these new jobs the two core competencies are: learning complex things fast and delivering high quality work at a high level (Newport, 2016). Being focused at work is therefore crucial to performing well in jobs of the future.

Not everybody realises that the quality of the physical office has a serious impact on stress and performance of knowledge workers. Employees are often placed in fewer square metres with more people doing many things, very visible. This makes the work stressful, exhausting and sometimes even impossible. Research supports that because of the attention on openness and increasing dynamics, individual focus work is jeopardised and leads to dissatisfaction (Pullen, 2017) and reduced performance (Compernelle, 2014). In many cases a comfortable, healthy and productive indoor environment is therefore not actually achieved.

In this whitepaper, the focus will be on understanding how our brain functions best at work, the importance of concentration, and practical guidelines to design an office environment with an understanding of brain and cognition. This whitepaper is an extension of the whitepaper from 2015: *'Towards a productive environment for brain workers'* (Tietema, 2015) and is developed for the Smart Workspace Design Summit 2017 in Amsterdam.

## 2. Our brain at work

To understand the needs of our employees, we should start looking at our brain first. In a very busy office space with a lot of distractions and a poor sound environment, many brain connections are activated at the same time. This leads to fragmented attention. Fragmented attention conflicts with focussed attention. Being efficient while multitasking is therefore a myth. When multitasking, we lose speed and accuracy, caused by attention residue. Therefore performance will decrease (Newport, 2016). The formula for learning is: attention + memory = learning (Rock & Schwartz 2006). When learning, our brain creates myelin. Myelin is a layer that has insulating properties around neurons and helps cells to function faster. The more myelin is produced the better neurons will perform (Fleschig, 1920). So to learn complex things fast, focus without any distractions is needed.

### 2.1 Conscious and subconscious input that affect concentration

People response to distractions is sometimes conscious and sometimes subconscious. A million bits of information is processed via our senses in different ways. Our senses can be divided in three groups(Lombard, 2007):

1. Informative senses (seeing and hearing);
2. Social senses (touch, scent and taste);
3. Regulating senses (movement).

Of these senses the informative and regulating senses are most linked to concentration capabilities of employees (Lombard, 2007). 80% of our brain (reflex and archiving brain [2.2]) is subconscious. This means that only a small part of the sensory input that is processed, leads to conscious perception (Dijksterhuis, 2011). This makes it extremely difficult to get into a concentration 'flow' and this also means that we can be affected by our environment without being consciously aware of this.

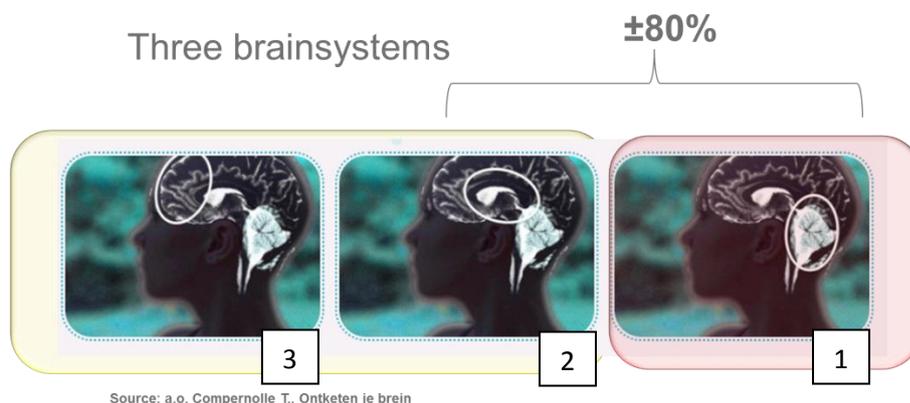
## 2.2 Three brain systems

The senses are the basis of how our brain gets input. We have three brain systems. Compennolle refers to this as the reflex brain [1], archiving brain [2] and thinking brain [3] (Compennolle 2014) [fig. 1]. The reflex brain [1] (brain stem) is responsible for the direct responses on sensory input. Sensory input is fully automatic, beyond our control and subconscious. Very convenient when we needed to fight or flee in the early days, but a handicap in some office spaces where we are subconsciously affected by moderate to high sound levels. We produce adrenaline and stress hormones, get sick and lose motivation without even being aware of this (Fried et.al, 2002; Evans et. al, 2000). The archiving brain [2] (limbic system) is like the reflex brain subconscious. This part of the brain is responsible for emotion, motivation and social behaviour. It collects information from both the reflex brain and the thinking brain and decides what needs to be stored for long-term memory. It is active unless our thinking brain is used on full capacity, for example when performing complex tasks. Research of Oommen (e.g.) shows that people are more socially isolated, easier irritated and less emphatic, when subjected to medium-high sound levels (Oommen, 2009; Brennan, 2002; Croon, 2005). This means that privacy and focus are also needed for successful and meaningful cooperation and communication.

The thinking brain [3] (our neocortex) is our 'highest' brain system and this brain system separates us from the animals. This brain system reflects about the present, past and future. It consists of our language, analytic and synthetic thinking, creative thinking, problem solving, forward thinking and in-depth thinking. In contrary to the other brain systems it is conscious. The thinking brain is slow and can be compared to brain-fitness. It is like a muscle that gets easily tired and can only work on one thought at a time. To use this part of the brain, employees need will power and resources, which are not infinite. As soon as the thinking brain takes a 'break' the archiving brain is working full speed to store the information needed in our long term memory. When employees stop multitasking and organisations design an office environment accordingly, than tasks take less time and the quality of work improves (Compennolle, 2014; Newport, 2016).

**Figure 1 Three brain systems**

(F.l.t.r. Thinking brain/Neocortex; Archiving brain/Limbic system; Reflex brain/brainstem)



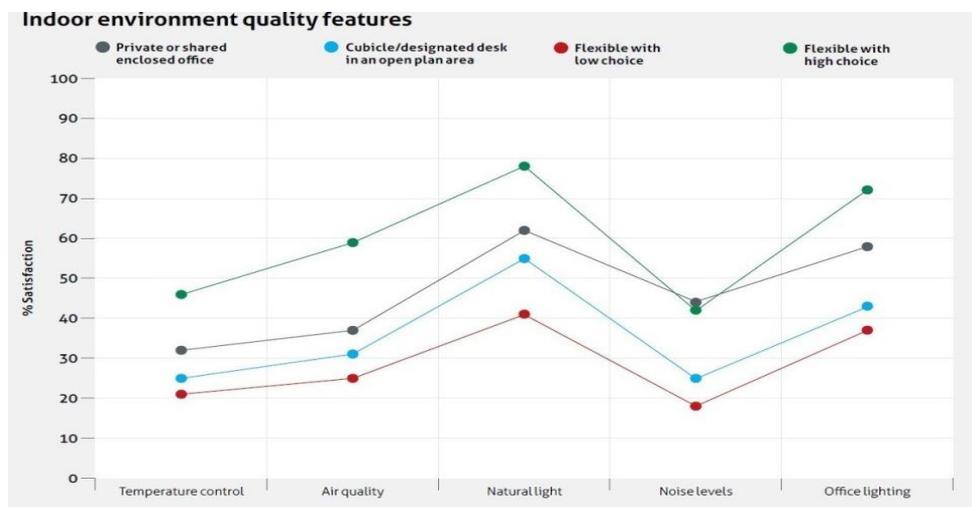
### 3. Distractions in the open office space

With all these bits of conscious and subconscious information you can imagine it is really hard, and for some people, even impossible to get into a ‘flow’ of concentration. However, this does not mean that companies should not care. Companies create open environments (often with poor acoustics) where management and employees can physically see each other, without considering the real consequences on productivity. This means that visibility and overhearing other people talking is often overvalued by companies and in contrast to what is believed it can work counterproductively. This trend, originated from the ideas of Taylor in the industrial era, and lead to that at least 65% of the office workers feel that the sound in the office has a negative influence on their performance (Hodsman, Oseland, 2015). This is quite disturbing as one knows that 82-92% of organisations-overhead is staff related (WGBC, 2014; Banburry, et al., 2005). But not only concentration is affected. According to research by Newport, a superficial working day causes negativity and dissatisfaction (Newport, 2016). Only when employees reach deep concentration, they get into a flow. This flow is linked to happiness, which is important for employees on all levels. How brain friendly is your office?

#### 3.1 Designing for quantity and quality

The design of the office has a big influence on how we experience different indoor environmental qualities (Leesman, 2014) [fig. 2]. Creating workspaces with a high flex-factor and not enough variation leads to dissatisfaction and loss of productivity (Banbury & Berry, 1998; Leesman, 2014). Really understanding what the work of employees is about, and the type of employees you have, is crucial when creating an environment for brain and cognition.

Figure 2 Indoor environmental qualities and design of office

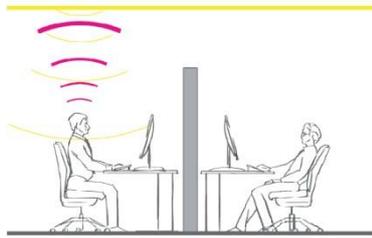


#### 3.2 Room acoustics

Because concentration is so important to do work, it is not surprising that good acoustics is rated as very important for office workers (Leesman, 2014). It is, however, given less attention than other architectural and engineering aspects (NRC Q, 2015) (Salter C., 2003). This is due to the lack of sound guidelines or the failure to execute them (Bakker, 2010). The previous whitepaper consist detailed information regarding how to handle sound levels and absorption classes. In figure 3, three ‘simple’ steps that can be followed to reduce sound levels in your office environment [fig. 3]. Be aware that there is no one size fits all solution.

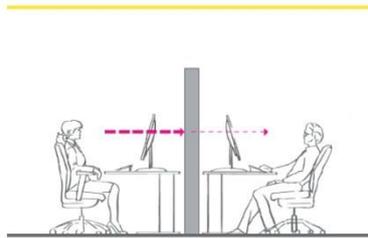
Figure 3 Three steps creating a better open office sound environment

### Step 1. Reduce sound levels



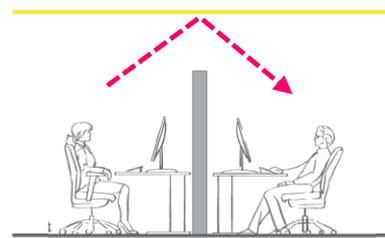
Use a ceiling with a high absorption class A (ISO11654) or AC-value of  $\geq 180$  (ASTME-1111)

### Step 2. Reduce disturbances



Use of screens min. height 1.4m and/or zoning

### Step 3. Reduce sound propagation



Ceiling with AC-value of  $\geq 180$  (ASTME-1111)

## 3.3 Personal characteristics

Noise levels measured in open spaces hardly ever exceed 65 dB(A) (Pierrette, et. al., 2015). So when assessing the open office environment more aspects than just sound pressure levels and room acoustics needs to be taken into account. Aspects as the type of sound, if people feel that they have control over sound, acoustical privacy and noise sensitivity are factors that create acoustical (dis)comfort (Hodsman, Oseland, 2015; Braat, 2017). Pierrette (2015) created a noise sensitivity (or GABA) survey. In this survey respondents needed to rate different statements. When you (strongly) agree with these examples from the survey, than it could indicate that you are noise sensitive: *“I need a completely quiet environment in order to have a good night’s sleep; I get very agitated when someone is speaking when I’m trying to sleep; I have problems getting used to noise in an open office environment quickly”* (Pierrette, 2015).

The research of Oseland (2016) shows that there are certain personality traits that correlates with higher noise sensitivity. The different personality traits were evaluated by using the Big Five-NEO inventory. The outcome was that people scoring high on introversion and neuroticism were more affected by noise than people that scored average or low on these variables (Oseland, 2015). Another aspect regarding perception of sound and personal characteristics is the research of Collings et.al. (1986) on the locus of control<sup>1</sup>. This research shows that people who have an internal locus of control perform better in noisy environments than people with an external locus of control. This could be an explanation why *‘internals’* are less bothered by sound, as their circle of influence is bigger than the one of *‘externals’*.

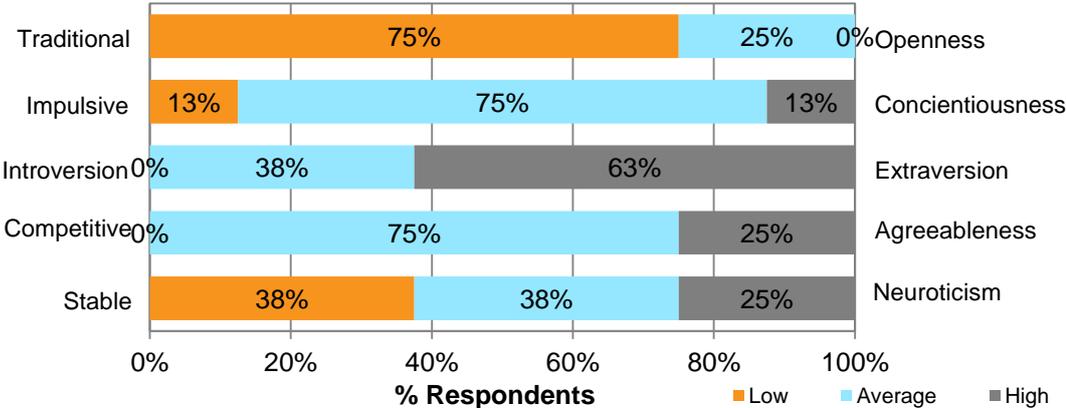
## 3.3 Acoustical etiquette

In the previous whitepaper I stated that the knowledge worker himself has also an important role to play, which can determine the success or failure of the concept. *‘If people are moving to a new setting it is worth involving them as closely as possible in this process. First by asking them what they need (the activity analysis), taking them to example projects and by explaining the ideas behind a given concept.’* This explanation can be done in different ways and our method [chapter 4] can not only help with the design, but also to help to communicate this message in the right way. Below you

<sup>1</sup> Locus of control is the degree to which people believe that they have control over the outcome of events in their lives

will find a team profile from company 'X'<sup>2</sup> from our Psycho-acoustic evaluation method. Only the high scores in orange and grey will be discussed. The team scored high on 'Traditional'. These individuals in general want to hear facts and details first and can be more reluctant to change (John, et.al., 2008). They are also less likely to change seats during the day. This implicates that when implementing a new etiquette, the company should be very specific and list all relevant details regarding desired attitudes. What do these new attitudes mean? How to use them? Senior Management should present these and be clear on what is expected of the employees behaviour in the various office environments (Owens, 2015). It is also important to recognize that they prefer traditional and formal collaboration and probably will do more concentrated work behind their desk in the open office environment and for meetings go to a formal meeting room.

**Figure 4 Team profile Company 'X'**  
(Orange left axes, blue average, grey right axes)



Another trait that stands out is that the team is more extraverted. This means that they are looking for action and interaction with groups. Company 'X' could provide workshops for employees to work on a case together and see how these attitudes can fit their current working patterns and how they can implement the etiquette in their daily job. This personality trait could be very positive to achieve an open and engaging culture, however they are probably also the ones who make the most noise. Therefore the extra rooms with clear instruction for concentration are necessary.

In my previous whitepaper examples of a good acoustical etiquette are given.

#### 4. Psychoacoustic measurement tool

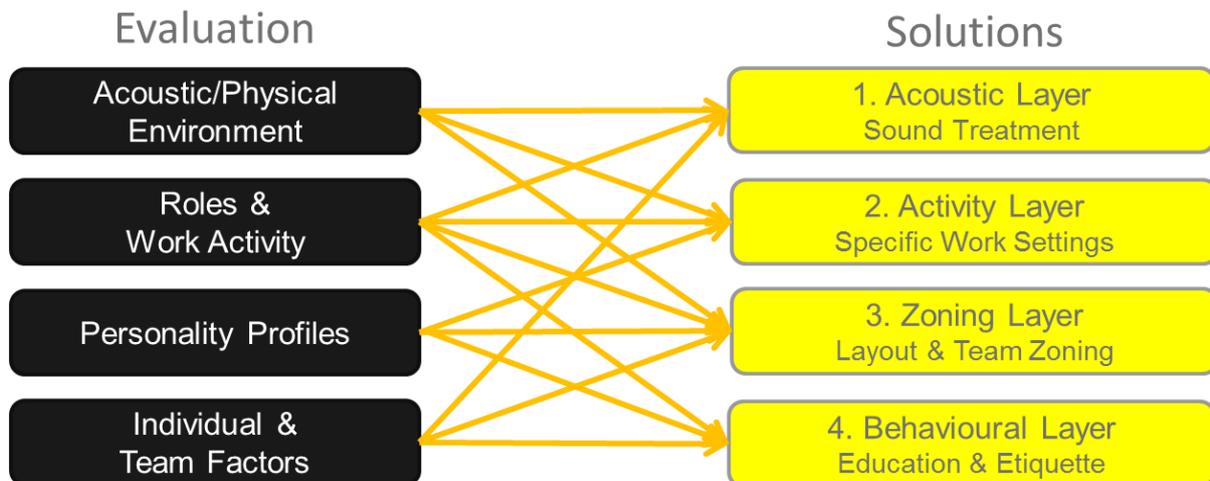
To get a better insight in how to create a working environment for concentration and collaboration, it is important to look beyond the well-known acoustic parameters like reverberation time (RT), sound propagation (D2s) and speech clarity (C50). It is about the combination of people, room and activity.

Oseland and Ecophon worked together to create an easy accessible evaluation method which can be used to give a better insight into (almost) all aspects which are important for the sound perception and concentration possibilities of employees [fig. 5]. The outcome is an analysis and diagnoses which companies and architects can use to create a new working environment that fits the needs of

<sup>2</sup> Company X likes to stay anonymous and will just be used to explain the concept.

workers in an organisation. We want to create an office environment that helps employees to concentrate, be happy and engaged.

Figure 5 Psychoacoustic evaluation method



## 5. Wrap up

Put knowledge workers and their needs first! When an office is designed, the first priority must be to give the knowledge workers privacy and to protect them against undesirable interruptions via all senses. Acoustic comfort can be created when the full package is evaluated before designing a work environment. Take room acoustics, roles and activities, personality profiles, individual and team factors into account to find the optimal solution.

Would you like to check the (psycho)acoustic environment in your office without any obligations? Come to the SWDS presentation Thursday 12<sup>th</sup> October 16 PM in Amsterdam. Or contact me or one of my colleagues listed below:

The Netherlands: [Yvette.Tietema@ecophon.nl](mailto:Yvette.Tietema@ecophon.nl)

Denmark: [MortenRoar.Berg@ecophon.de](mailto:MortenRoar.Berg@ecophon.de)

Finland: [Arto.Rauta@ecophon.fi](mailto:Arto.Rauta@ecophon.fi)

Germany: [Rainer.Machner@ecophon.de](mailto:Rainer.Machner@ecophon.de) ; [Holger.Brokmann@ecophon.de](mailto:Holger.Brokmann@ecophon.de)

India: [Manit.Ramaiya@saint-gobain.com](mailto:Manit.Ramaiya@saint-gobain.com)

Poland: [Magda.Szubert@saint-gobain.com](mailto:Magda.Szubert@saint-gobain.com)

Russia: [Alexey.Archakov@saint-gobain.com](mailto:Alexey.Archakov@saint-gobain.com)

South Africa: [Lauren.Kruger@saint-gobain.com](mailto:Lauren.Kruger@saint-gobain.com)

UK & Ireland

[Paige.Hodsman@ecophon.co.uk](mailto:Paige.Hodsman@ecophon.co.uk)

For any other country:

[Carsten.Svensson@ecophon.com](mailto:Carsten.Svensson@ecophon.com)

## Bibliography

- Bakker, I. (2010). *De breinwerker*. Naarden: Uitgeverij FMN.
- Banbury, & Berry. (1998). *The disruption office-related tasks by speech and office noise*. British journal of psychology, Vol.98, 499-517.
- Banbury, & Berry. (2005). *Office noise and employee concentration: Identifying causes of disruption and potential improvements*. *Ergonomics*, Vol. 48, No1, 25-37.
- Braat-Eggen, E., Van Heijst, A., Hornikx, M. & Kohlrausch, A. (2017): Noise disturbance in open-plan study environments: a field study on noise sources, student tasks and room acoustic parameters, *Ergonomics*, DOI: 10.1080/00140139.2017.1306631
- Brennan, A. (2002). Traditional versus open office design: A longitudinal Field Study. *Environment and behavior*, vol 34, 279.
- Collins-Eiland, K., Dansereau, D., Brooks, L., Holley, C. (1986). Effects of conversational noise, locus of control, and field dependence/independence on the performance of academic tasks. *Contemporary Educational Psychology 11, 2*.
- Compernelle, T. (2014, juli 4). *Brain-Hostile Open Offices: The fifth brain chain*. Opgeroepen op juli 20, 2015, van Brainchains: [www.brainchains.info](http://www.brainchains.info)
- Croon, E. d. (2005). The Effect of Office Concepts on Worker Health and Performance: A systematic review of literature. *Ergonomics vol. 48 no. 2*, 119-134.
- Dijksterhuis, A. P. (2011). *Het slimme onbewuste*. Prometheus.
- Evans, & Johnson. (2000). Cornell university, "Stress and Open-Office Noise. *Journal of Applied Psychology*, Vol. 85, No. 5, 779-783.
- Flechsig, P. (1920). *Anatomie des mensliches Gehirn und Rückenmarks*. Leipzig: George Thieme
- Fried, Y., Melamed, S., & Haim, A. (2002). The Joint Effects Of Noise, Job Complexity, And Gender On Employee Sickness Absence. *Journal Of Occupational And Organizational Psychology*, 75 (2), 131–144.
- John, O., & Robins, R. (2008). *Handbook of Personality, Third Edition: Theory and Research*. New York: Guilford Publications, 114-158.
- Leesman. (2014, Q4 issue 16). Leesman\_review. Opgehaald van Leesman: <file:///C:/Users/Y8133878/Downloads/Leesman%20Review%20Issue%20Leesman%20Review%20Issue%2016.pdf>
- Lombard, A. (2007). *Sensory intelligence: why it matters more than IQ and EQ*. Welgemoed, South Africa: Metz Press.
- Newport, C. (2016). *Deep Work*. New York: Grand Central Publishing.

NRC Q. (2015, maart 25). Last van herrie op het kantoor? Je bent niet de enige. Opgeroepen op juli 15, 2015, van NRC Q: <http://www.nrcq.nl/2015/03/25/genoeg-van-de-herrie-je-bent-niet-de-enige>

Oommen, V. (2009). Should Health Service Managers embrace open plan work environments? A review. *Asia Pacific Journal Health Management* 3, no.2.

Oseland, N., & Hodsmann, P. (2015). People centred offices, A psychological approach to resolving office noise distraction. Londen: Workplace Unlimited, Saint-Gobain Ecophon.

Oseland, N. (2015). Psychoacoustics survey results: psychological factors affecting noise distraction. Workplace Unlimited.

Owens, M. (2015, August 13). Personality Type in the Workplace Blog. Retrieved July 24, 2017, from <https://www.typefinder.com/blog/3-exercises-help-sensors-and-intuitives-communicate>

Pierrette, M., E. Parizet, P. Chevret, and J. Chatillon. 2015. "Noise Effect on Comfort in Open-space Offices: Development of an Assessment Questionnaire." *Ergonomics* 58 (1): 96-106.

Pullen, W. (2017). Geeft het flexkantoor reden tot bedenkingen? Nieuwsbericht op [www.cfpb.nl](http://www.cfpb.nl) (2017).

Rock, D., & Schwartz, J. (2006, May 30). The Neuroscience of Leadership. Retrieved July 14, 2017, from <https://www.strategy-business.com/article/06207?gko=6da0a>

Salter C., P. K. (2003, Januari). Case studies of a method for predicting speech privacy in the contemporary workplace. UC Berkeley: Center For The Built Environment.

Tietema, Y (2015), Naar een productieve werkomgeving voor breinwerkers: strategieën voor het creëren van de optimale akoestische werkomgeving. Saint-Gobain Ecophon.

WGBC. (2014). Health, Wellbeing & Productivity in Offices. Londen: World Green Building Council.