

Office Design's Influence on Employees' Stress Levels

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This is an explorative study on the office design's relation to employees' stress levels and the architectural and functional features of the different office types, which are hypothesized to influence the employees' stress level. The main questions at issue are: 1) Are there differences in stress levels between employees in different office types, 2) If so can these be explained by the features of the office types? and 3) Are there gender-related differences in which office types are perceived as stressful or not?

The article is based on a sample of employees (n=468) in seven different office types that have rated their stress level on a twelve items stress index. Different statistical methods were used, e.g. univariate and multivariate logistic regression models.

The results show differences in stress levels between office types but also differences between men and women in perception of stress in different office types. These differences remain after adjustment for background factors. Though the base of the study is architecture a multi-disciplinary approach is applied since office design needs to be understood in the context of health and organizational aspects, which are found in areas of occupational health and organizational psychology. The results are discussed in a holistic context and also how to apply knowledge about employees' psychological and physical health into the design process.

Keywords: office design, stress level, gender, employees, office type, architectural features, functional features

Introduction

Today a majority of the labor force works in offices in Western society (Brill, Weidemann, Alard, Olson, & Keable, 2001), a great part of these people's waken hours are thus spent in office environments. This fact combined with reported severe problems of emotional health among the white-collar employees in Sweden (Åsberg, Nygren, Rylander, & Rydmark, 2002) lead us to investigate what part the office design plays for the stress levels. The need for knowledge on this subject is great as the research that has investigated the influence of the building environment and its architectural features on human health is limited (Evans, 2003; Evans & McCoy, 1998).

A large part of the research on environmental influences on human health has focused on natural environmental features (e.g., Hartig, Bök, Garwill, Olsson, & Gärling, 1996; Hartig, Evans, Jamner, Davis, & Gärling, 2003;

Kaplan, 1995; Ulrich, 1993). With regard to the built environment the focus is often on ambient factors like light, noise, and air quality (e.g., Apte, Fisk, & Daisey, 2000; Bengtsson, 2003; Evans & Johnson, 2000; Lahtinen, Sundman-Digerts, & Reijulas, 2004; J. A. Veitch, 2001). The research on the influence of the built environment itself has focused on health care (e.g., Dijkstra, Pieterse, & Pruyna, 2008; Ulrich, 1984, 2001), residential (e.g., Hartig, Johanson, & Kylin, 2003) or urban settings (e.g. Evans, 2003), whereas there is a lack on the office environment's impact on health and well-being. The research that exists is often focused on open plan offices, and then often with a general approach (Evans & Johnson, 2000; Oomen, Knowles, & Zhao, 2008). There is a lack of recognition that there are different types of offices with open plan layouts that may influence employees differently. The review by de Croon et al. (2005) on the effect of office concepts with regard to office location, layout and use on employees' health status and performance is to our knowledge the only attempt in investigating the layouts importance for health

outcomes. To the authors knowledge the study by Bodin Danielsson & Bodin (2008) is the only study that investigates the impact of different features of office types on employees health status and job satisfaction. That study does however not investigate the office types' features in relation to stress.

Work plays a significant part in the life for a majority of people; its importance for the welfare of people both on as well as off work is acknowledged in occupational research (e.g., Marshall & Cooper, 1978).

The impact on employees' health status by the psychosocial environment¹ is recognized (Karasek & Theorell, 1990; Siegrist, 1996). Research has e.g. shown that the mere topic of work leads to erratic and dangerous ECG readings among patients that had survived a heart attack (Theorell, 1974).

Though some stressful conditions occur across most jobs, such as conflicts with co-workers or heavy workloads, others are specific for an occupation. For instance for an artistic occupation such as orchestra musicians a major stressor is having to violate the artistic integrity, and for a nurse the death of a patient (Spector, 2006). Also the psychosocial environment and management style vary between organizations and lines of business due to differences in organizational culture (e.g., Lämsäalmi, Peiró, & Kivimäki, 2000). Finally the character and amount of workload vary with occupational level; it is established that job pressure is higher among middle managers than at lower as well as higher occupational levels (Marshall & Cooper, 1978). However, if an individual will develop stress-related disorder is, according to Ivancevich et al. (1982), at an individual level depending on: 1) the dimensions or characteristics of the person, combined with 2) environmental stressors at work. This explanation is called Person-Environment (P-E) Fit model (see French, 1974, Lofqvist et al. 1969, Van Harris, 1978 in Ivancevich et al., 1982).

Recognizing the complexity of occupational stress this article is a first attempt to investigate what part the office design plays in determining whether an individual will develop stress disorders or not. We therefore set out to investigate if the office type itself affects employees' stress levels.² There is a need to investigate the office environment's possible impact on employees' stress levels as most occupational health and stress research is conducted among blue-collar workers and in health care

and service sectors (e.g., Aust, Peter, & Siegrist, 1997; MacDonald, Colotla, Flamer, & Karlinsky, 2003; McVicar, 2003). The lack of research on health among white-collar workers in office environments is evident. These factors combined with the fact that it is well documented that open plan offices reduces privacy and job satisfaction among employees (de Croon et al., 2005; Sundstrom, Burt, & Kamp, 1980) motivate our study.

We believe that the dependence of the features that differentiate office types on employees' welfare has not been fully recognized in office research. With regard to offices with open plan layouts it is e.g. easy to assume these office types may lead to higher stress levels among employee and we therefore found it important to look closer at this specific question. In addition we also wanted to investigate possible gender differences in stress in different office types. And if so, could these differences be traced back to the features of the office types. This study is thus an attempt to investigate the question in an explorative manner by recognizing other features in office design than the plan layout in the analysis.

Purpose

The research questions based on our hypothesis are: a) "Are there differences in self-reported stress levels among employees in different office types? If so: b) "Can these differences be traced to the architectural and functional features that define the seven different office types identified in modern office design?" A further question is c) "Are differences related to gender?" To test the hypothesis employees of twenty-six companies or divisions in larger companies in the Stockholm area, Sweden was investigated.

Method

Sample

The layout of the sampling plan has been described in detail in Bodin Danielsson & Bodin (2008, 2009). The basic feature was a selection of 26 companies and from each company individual respondents were selected. Participation was voluntary.

The response rate was 72.5% (men 68%, women 74%). Questionnaires were received back from 491 office employees (men $n = 247$, women $n = 236$, no information on gender $n = 8$; mean age 41 years, range 21-64 years) and form the base of the study. The characteristics of the

companies varied because some were small, local companies, whereas others were large, international companies. The number of employees in the companies represented in the sample ranged from 10 to about 100 employees. Some companies/divisions included up to four different office types, whereas others consisted of a single office type (see appendix in Bodin Danielsson & Bodin, 2008).

In the multivariate analysis, 23 subjects were excluded because of (a) employment in the service sector (three subjects; too few to be analyzed), (b) missing information on the pre-specified confounders (16 subjects), (c) missing information on office type (three subjects) and (d) missing information on the stress questionnaire (1 subject). Consequently, 468 out of the 491 subjects remained for the analysis. The number of employees in the different office types varied, ranging from 131 employees in cell-offices to 26 employees in shared-room offices.

Office definitions

In order to compare the influence of different office environments on employees it is necessary to categorize them. Office environments have traditionally been defined either by spatial organization or by work organization. Only using one method has its limitation as both factors influence the office employees. In contrast this article analyzes the office environments based on their unique combinations of *architectural features* and *functional features*. The most dominant architectural feature is the spatial organization of an environment. The functional features are based on the actual work taking place in the office. The seven identified office types in contemporary office design should be construed as prototypes (for details and illustrations see Bodin Danielsson, 2007; Bodin Danielsson & Bodin, 2008). They are defined as follows:

- (1) The *cell-office* is a room office for a single person. The plan layout is characterized by corridors where every room has access to a window. Most equipment is in the room. The office work is often highly concentrated and independent.
- (2) The *shared-room office*³ is a room shared by two to three people. The shared rooms are either a result of a team-based work organization that emphasizes interaction within projects or a consequence of a lack of space. In the latter, the people tend, nevertheless, to have similar work assignments. Most office equipment is outside the room, though the team-based shared rooms sometimes have their own equipment within the room.

Open-plan Offices

The open-plan office is defined by employees sharing a common workspace. There are neither walls between workstations nor access to individual windows. The work is often routine processing with low levels of interaction between employees. The purpose of these office types is to be flexible to organizational changes and to handle these without any reconstruction. To reduce noise and create some privacy, there are often screens between workstations. The open-plan office exists in different configurations, depending on the amount of people sharing the workspace. This study uses three different definitions of the open-plan office:

- (3) The *small open-plan office* holds four to nine people per room. It is a good size for teams (Mullins, 2008; Svedberg, 1992).
- (4) The *medium-sized open plan office* holds 10 to 24 people per room. It is the most common size of open plan offices in Sweden (Christiansson and Eiserman, 1998).
- (5) The *large open-plan office* holds more than 24 people per room. It is e.g. not very common in Sweden, but in countries like the U.S.A.

Office types With a More Flexible Design

- (6) The *flex-office* is defined, often but not always, as an open-plan layout where employees lack any personal workstations. It is the most flexible office type, since not only the office plan is flexible but also the work-schemes of the employees. A good information technology (IT) system is necessary, since the choice of workstation is free and all work is dependent on access to the common computer system. The flex-offices are dimensioned for less than 70% of the workforce to be in office at the same time. Work outside of the office is expected to lead to this occupancy figure.
- (7) The *combi-office*⁴ has no strict spatial definition. Instead, teamwork and the sharing of common facilities define it. There is good access to back-up spaces for teamwork, meetings, etc. Work within the office takes place more than 25% of the time at places other than the personal workstation on an as-needed basis. The work is characterized by both independence and interactivity in teamwork.

Neither the quality of architectural details and environmental differences (e.g., height and material on partitioning systems and amount of window space

available) nor differences in density define the office types. The seven office types act as broad categories, and there are variations between, as well as within, the office types concerning these aspects. The cell-office stands out as the clearest definition because all other office types imply sharing the workspace and amenities between employees to varying degrees.

Sociodemographics

There were some differences in the distribution of sociodemographic data within the sample and between the office types. In short the 468 office employees had a fairly uniform distribution with regard to age and gender. The middle-low job rank was the largest category and media/Information Technology (IT) was the most frequent line of business. Details on the distribution of the distribution on background factors and the specific characteristics of the office types depending on these are described in (Bodin Danielsson & Bodin, 2008).

Questionnaire

This article is based on items covering the general background of the respondents obtained from the studies of health status and job satisfaction by Bodin Danielsson & Bodin (2008), and environmental satisfaction by Bodin Danielsson & Bodin (2009), supplemented with specific questions concerning stress given in a 20 items questionnaire by Burell (2002). Out of these twenty questions we have chosen to analyze the shorter version of a stress index where twelve questions were used, (Burell, 2002). The following twelve items⁵ were used to measure the respondents' stress level:

- 1 (a) *I feel like I am under time pressure,*
- 2 (c) *I hate standing in line,*
- 3 (d) *I get frustrated with other drivers easily,*
- 4 (e) *I am at high speed and I push myself hard,*
- 5 (f) *I easily get frustrated when people are slow,*
- 6 (h) *I often do two or more things at the same time,*
- 7 (i) *I feel irritated and upset without showing it,*
- 8 (k) *I can find myself hurrying, even when I have plenty of time,*
- 9 (l) *I get frustrated with people who are fumbling or sloppy*
- 10 (m) *I eat quickly and I am usually done first,*
- 11 (q) *I find it hard doing "nothing",*
- 12 (t) *People tell me to slow down and take it easy.*

These items were all scaled in four categories ranging from "Never/Rarely", "Sometimes", "Rather often" to "Very often",

scored as 1 to 4. The sum of the twelve items formed a summary index for stress behavior with a scale from 12 to 48. Before analysis we dichotomized the index with cut-points given by Burell (2002) with below 30 indicating no or minor stress and 30 or above indicating considerable or heavy stress behavior.

Statistical Methods

The different statistical methods in this study are basically the same as those used in Bodin Danielsson & Bodin (2008, 2009) and therefore we will here sketch only the basic principles for analysis. A cross-tabulation of the dichotomized stress index against office types was followed by a multivariate logistic regression with Odds Ratio (OR) as the outcome parameter. Prior to the analysis, cell office was chosen to represent the reference category with which the other office types were compared using the OR.

Gender, age, job rank, and line of business were added to the multivariate regressions because they are factors that are supposed to have an effect on the outcome parameter and cause biased estimates if they are not included in the model. The outcome parameter OR is by definition 1.0 for cell office, the reference category, OR >1.0 indicate a higher risk for inferior stress level compared to the cell-office and OR < 1.0 a lower risk. Statistical significance was set at $p < 0.05$. Processing of statistical data was done using the statistical software package STATA, version 10 (StataCorp, College Station, TX, USA)

Results

The prevalence of stress symptoms ('Low or no stress' versus 'Stress or severe stress') for the seven office types and for gender is shown in Table 1.

The overall percentage of stress is 21% with the lowest figure for small open plan office, 12%, and the highest figure for combi-office, 35%. Females show almost a twice as high prevalence of stress symptoms compared to men, that is, 28% versus 15%. For the background characteristics (data not shown in table) the prevalence for age goes from 32% for 21-34 years to 19% for 35-49 years and 12% for the oldest group above 49 years of age. Middle-high job rank has a prevalence of 33% whereas the other job ranks are in the range 16% to 21%. The Media/IT sector has a prevalence of 27%, personal and economic

guidance 22%, technical professions 15% and business administration and management has 14%.

The more detailed description of the prevalence for gender show that for all office types except large open plan offices, females have higher stress levels than males. For large open plan office the figure for females is 15% and for males 18%. All of the prevalences in Table 1 are given without adjustments for other factors.

With a multivariate analytical perspective from the logistic regression model and the Odds Ratio (OR) as outcome the relationship between the office types changes quantitatively (differences become smaller), see Table 2. The ranking of the office types is however almost the same as in Table 1. With cell-office as reference the smallest OR is found for small open plan office, 0.5, followed by large open plan office, 0.7, flex office 1.2, medium open plan office 1.2, shared-room, 1.4 and the worst case is combi-office with 1.5. This indicates an increase in the odds of stress prevalence in combi-offices of 50% compared with cell office, and an even higher increase in odds compared with small open plan offices, that is, 300%. Due to the relatively small sample size these differences are not statistically significant though.

For females the OR from a multivariate analysis in the total sample is 2.2 with males as reference category, an increase in the odds of stress prevalence of 220%, a figure that in this case is highly significant. However, the stratification of the analysis into males and females gives indications that the office type does not effect females and males in the same way. For males the lowest stress prevalence is found in cell office with highly increasing OR:s for medium open plan office, 2.2, large open plan office, 2.5 and combi-office 2.8. For females cell office is not the most favorable office, since the lowest odds for stress is found in small open plan offices and large open plan offices, OR=0.3 compared with cell office. A somewhat increased OR is found in combi-office. For shared-room, medium open plan office and flex—office results are similar to cell office.

Additionally it was found that the OR:s for age, job rank and line of business agree well with the previous information given by the pure descriptive prevalences.

	Cell-office (reference category)	Shared- room	Small open plan	Medium-size open plan	Large open plan	Flex- office	Combi- office	All office types
	(n=131)	(n=26)	(n=43)	(n=56)	(n=74)	(n=81)	(n=57)	(n=468)
		(2-3 pers./ room)	(4-9 pers./ room)	(10-24 pers./ room)	(25 - pers./ room)			
All subjects	16 %	27 %	<i>12 %</i>	25 %	16 %	26 %	35 %	21 %
Men	10 %	21 %	<i>10 %</i>	17 %	18 %	14 %	23 %	15 %
Women	24 %	33 %	<i>13 %</i>	30 %	<i>15 %</i>	35 %	54 %	28 %

Note. Figures in bold indicate more stress symptoms than for cell office, figures in italics indicate less stress symptoms than for cell office.

Table 1. Percentage of employees in different office types reporting stress symptoms, for all subjects and for males and females separately.

	Cell-office (reference category)	Shared- room	Small open plan	Medium-size open plan	Large open plan	Flex- office	Combi- office
	(<i>n</i> =131)	(<i>n</i> =26)	(<i>n</i> =43)	(<i>n</i> =56)	(<i>n</i> =74)	(<i>n</i> =81)	(<i>n</i> =57)
		(2-3 pers./ room)	(4-9 pers./ room)	(10-24 pers./ room)	(25 - pers./ room)		
All subjects	1.0	1.4	<i>0.5</i>	1.2	<i>0.7</i>	1.2	1.5
Men	1.0	1.9	1.3	2.2	2.5	1.8	2.8
Women	1.0	<i>0.9</i>	<i>0.3</i>	<i>0.9</i>	<i>0.3</i>	<i>0.9</i>	1.2

Note. OR < 1.0 indicate lesser risk for stress symptoms than for Cell Office, OR > 1.0 higher risk. All comparisons are within all subjects or within gender. OR in bold indicate higher risk for stress symptoms compared with cell office, OR in italics indicate less risk.

Table 2. Odds ratios (OR) from a multivariate analysis of stress symptoms for all subjects and for males and females separately. The reference category is Cell office (OR=1.0) and the multivariate logistic model included office type, and adjusted for gender, age, job qualification and line of business, though gender was not included in the gender-separated analysis

Discussion

The descriptive data showed great differences in perception of stress between the office types, where combi-office employees were most stressed overall, but also for both genders independently (Table 1). The vulnerable position for combi-office's employees was already established in a former study on job satisfaction (Bodin Danielsson & Bodin, 2008), thus the result was of no surprise.

The descriptive data also showed that women independent of office type reported higher stress levels in comparison to men, a result established in several other studies (e.g., Borell, Munanter, Benach, & Artazcoz, 2004; Chesney & Orth-Gomér, 1998; Lundberg & Frankenhauser, 1999). However the magnitude of the difference between the genders in this study is high and the fact that the genders ranked the office types differently regarding to stress was a surprise.

The questions we set out to investigate require a deeper analysis than a pure descriptive analysis, which leaves out the possible influence of background factors on the relationship between stress and office type. The multivariate analysis showed that office type has an impact

as differences in stress remained between the office type, though they are not statistically significant. Also the difference between men and women in the ranking of the office types as more or less stressful remained with combi-office as the office type with highest risks for stress among its employees.

The question is though why the stress level is much higher in combi-office than flex-offices, which has the same architectural features? Both office types mean sharing of workspace between colleagues to different degree and good access of "back-up rooms" for concentrated work, meetings and telephone calls. The explanation might thus instead be found in their different functional features. In combi-office there is a higher degree of collaboration and teamwork than flex-office, which is more individual and task oriented. Flex-office also offers more flexibility and freedom for the individual as it is possible to choose workstation freely within the office and work outside of the office. The differences between the office types' functional features have an effect on the employee's ability to exercise personal control. Personal control refers to autonomy; the desire for it is fundamental for humans and a vital component in our well-being (see e.g. Rothbaum, Weisz, & Snyder, 1982 for reviews). In the office it is exercised by psychologically and physically means (Lee & Brand, 2005;

O'Neill & Carayon, 1993; Rodin, Solomon, & Metcalf, 1978; J. A. Veitch, Gifford, R., 1996). The office type can reinforce or thwart personal control by its architectural and functional features. This means that architectural features such as size, location and permeability of interior rooms has an impact due to its influence on the degree of social control, interaction and privacy (see review in Evans, 2003). But also functional features such as ability to work flexible and support feelings of autonomy and confidence at work at an individual and group level has an impact on personal control.

The functional features of combi-office with a high degree of teamwork and little possibility to choose where and when to carry out work, may explain the higher stress level in combi-office than flex-office, as this is where the office types differ from each other. However, the major explanation for the high stress level among combi-office employees is probably not found in the features of the office type, but within the field of leadership and management as employees in combi-offices reported significantly lower job satisfaction compared to other employees (Bodin Danielsson & Bodin, 2008). Why this is the case is an interesting question, however outside the topic of this study.

Not only the office type's impact on employees stress levels was investigated in this study, but also the possible gender differences. Here we found both extreme differences in stress levels between office types for both genders and difference in ideal office types.

For women it was e.g. four times higher odds to report stress in combi-office than in small open plan office and large open plan offices (25- pers./room.). For men the ideal office type was instead cell-office, where the odds were almost three times lower to report stress than in combi-office.

Besides the high stress level in combi-office for both genders there was a great differences in ideal office types out of a stress perspective. For men the ideal office type was cell-office followed by small open plan offices (4-9 pers./room.). Women on the other hand reported the next highest stress level in cell-office. For women all office types that imply sharing of workspace in different constellation, appear to have a positive effect on stress, with the exception of combi-office. In other words the result revealed an almost completely different perception of stress between the office types for men and women. These

differences were found after adjustment for job rank, age and line of business. The result thus indicates other explanations such as difference in environmental stressors between the genders. The lower stress level among women in small open plan office and large open plan offices may be due to lower sensitivity for disturbance from noise, a well-known stressor in open plan offices (Evans & Johnson, 2000; Sundstrom, Town, Rice, Osborn, & Brill, 1994); especially common in large open plan offices (Bodin Danielsson, 2008). As we controlled for job rank the explanation for the outcome is not that women hold more routine based work, which is less sensitive to noise disturbance (e.g., Franzén, 1969; Haka et al., 2009). However the group size may in this case have an impact as women reported less stress in shared workspaces, while men reported lowest stress in cell-office. Why women have less preference for medium-sized open plan office than small or large open plan office might depend on its lower support for group identity and ability for anonymity or sub-groups to develop, which may be of greater importance among women.

As our data does not allow us to analyze the possible impact of status on the employees' stress level we can only speculate if the difference in stress levels between the genders in open plan office depended on this. A tentative explanation might be that women are less sensitive to office environment as a status indicator. We know that men preferred cell-office out of a stress perspective, whereas women preferred small and large open plan offices. We also know that cell-office offers ownership, personal control over the work environment and ability for privacy, all traditional means to express status in an office (e.g., Davis, 1984; Sundstrom, 1986), whereas traditional open plan offices offers none of this.

The question is though how can the results of this study be interpreted architecturally? The higher risk for stress among employees in combi-office in comparison to other office types points out two important factors to consider in office design in our opinion:

- 1) The choice of office type should support psychological and functional needs related to the work carried out in the office, and
- 2) The managerial leadership should go hand in hand with the choice of office type in order to create a "healthy" organization. Architects need to recognize these factors in the design of office environments but also make the clients and other parties in the design process aware of

the importance of these factors for the health and well-being.

With regard to the revealed gender differences in stress levels between different office types it is harder to implement it architecturally as most organizations hold members of both genders. The difference needs however to be recognized in an organizational setting though we need further research on possible gender differences in environmental stress in office. From the present study we can only say that it appears to be a complex interplay between architectural and functional features in the different office types that determine the outcome. Difference in perception of environmental stressors of different character between the genders, combined with factors such as managerial leadership, psychosocial environment etc. at the workplace should be put in relation to the office type.

Some limitations for the interpretation of the study results need to be pointed out. Stress was measured with self-reported measurements of type A personality profile, and no physiological data from saliva, urine or blood was used. It is an observational cross-sectional study. Thus no definitive cause-effect relationship could be established. The study was conducted in an urban setting, the Stockholm area. The results for the shared-room offices should also be interpreted with some caution, as the sample size for this office type was small. Finally, there is possibly also some hidden confounding in the multivariate model that may contribute to explain the results.

Conclusions

There are certainly other factors than the office type itself that influence employees' stress levels, e.g. workload, locus of control, leadership and management styles (Karasek, Baker, Marxer, Ahlbom, & Theorell, 1981; Karasek & Theorell, 1990; Sauter & Murphy, 1995), but the result shows that the office environment is a parameter to consider and that there is a gender dimension to office design. It is important to apply a broader perspective to office design and to incorporate other fields of research, social and behavioral, as many factors determine the work environment. Finally the results highlight the importance to incorporate other fields of research, social and behavioral in the design process, as many factors determine how good the work environment will be out of an individual and organizational perspective.

Notes

1. Psychosocial work environment is here defined as the nonphysical work environment, including the relationship with colleagues and supervisors.
2. Employees' stress level was measured with type A personality profile since hazardous stress behaviors have a well established link to Type A personality trait (Ivancevich et al., 1982). It is characterized by competitiveness, a constant struggle against time, an achievement-orientation and an intense sense of urgency (Ibid., p. 376).
3. According to Ahlin and Westlander (1991) an office shared by more than one person. The original definition in Swedish is "delat flerpersonrum" (room shared by several people).
4. The original combi-office was a combination of the cell-office and the open plan office, with individual offices facing a communal space where most office facilities were found. Today no strict spatial definition of combi-office exists; teamwork and the sharing of facilities define the office type. The employees may have individual offices or an individual workstation in an open plan office layout.
5. The original alphabetical order of the items in the questionnaire is shown within brackets in order to make it easier for the reader to go back to the source (Danielsson, 2005).

Biography

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