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ABSTRACT

This paper focuses on design innovation: that is, the development of products that are new in terms of products' appearance, the emotions products evoke, and/or the way they enable customers to express their identity. Although prior research acknowledges the importance of design innovation for product and organisational performance, studies on how to manage design innovation are relatively scarce. The present study attempts to fill this gap by investigating design innovation and its management in terms of the degree of exploration and exploitation activities and designers' decision freedom when developing new offerings. We collected data on projects in which external design consultancies were actively involved during the development process ($n = 83$). For each project, we surveyed both the external senior designer and the project manager at the client's side. Our results suggest that exploration activities enhance design innovativeness, and that design innovativeness results in better market performance. Furthermore, we find that exploitation activities moderate the relation between design innovativeness and process performance: when exploitation activities are high (low), design innovativeness results in better (worse) process performance. In addition, we find that when designers have decision freedom, the positive relation between exploration activities and design innovativeness is enhanced. However, our data also suggest that design innovativeness has a negative (positive) influence on market performance when designers have high (low) levels of decision freedom.

Introduction

Innovation is generally conceptualised in terms of new functionality, features, and technology; that is, 'technical' or utilitarian innovation. Innovation can, however, also relate to newness in terms of products' appearance, the emotions products evoke, and/or the way they enable customers to express their identity (Bloch, 2011; Chitturi, Raghunathan, & Mahajan, 2008; Gemser, Candi, & Van Den Ende, 2011). In this paper, this type of innovativeness is referred to as *design innovation*. Considering the different nature of design innovation compared to technical innovation, and the growing number of companies investing in design (Cameron, Knight, Hargreaves, May, & Goulding, 2015),

there is an increasing need for research on design innovation and how to manage it (Candi & Gemser, 2010). Prior research predominantly investigated the consequences of design innovation on organisational and product performance (Gemser et al., 2011; Korenok, Hoffer, & Millner, 2010; Landwehr, Wentzel, & Herrmann, 2013; Micheli & Gemser, 2016; Rubera, 2015; Rubera & Droge, 2013; Talke, Salomo, Wieringa, & Lutz, 2009). Research is however light on how to manage or facilitate design innovation (Cillo & Verona, 2008; Ravasi & Locajono, 2005).

In terms of management of design innovation and its outcomes, this paper will focus in particular on exploration and exploitation activities within innovation projects. Exploration activities relate to activities that search for new knowledge (Levinthal & March, 1993) and include activities that can be captured by terms such as 'search, variation, risk taking, experimentation, play, flexibility, discovery' (March, 1991, p. 71). The returns from exploration activities are distant in time, uncertain and weakly connected to the current actions of the organisation (March, 1991). Exploitation activities, on the other hand, are related to the organisation's efforts to improve the knowledge it already has (Levinthal & March, 1993) and can be described by activities such as 'refinement, choice, production, efficiency, selection, implementation and execution' (March, 1991, p. 71). These activities improve present returns, which are relatively certain and closely related to the organisation's current actions (March, 1991). Prior research suggests that exploration activities are the basis for exploitation activities: once new knowledge is generated, it can be exploited (Levinthal & March, 1993; March, 1991). Several prior studies demonstrated that the degree of exploration and exploitation activities in the innovation process has an impact on outcomes, for example, in terms of degree of innovativeness (Kim & Atuahene-Gima, 2010; Molina-Castillo, Jimenez-Jimenez, & Munuera-Aleman, 2011; O'Cass, Heirati, & Ngo, 2014), cost efficiency (Kim & Atuahene-Gima, 2010; O'Cass et al., 2014), or quality (Molina-Castillo et al., 2011). However, these studies were all focused on technical innovation. No prior study exists examining this for design innovation.

This paper will also examine designers' decision freedom in design innovation. Prior research suggests that designer decision freedom is an important aspect to manage within innovation development projects as it may affect the level of innovativeness of outcomes (Gemser et al., 2011; Micheli, Jaina, Goffin, Lemke, & Verganti, 2012; Ravasi & Lojacono, 2005) and market success (Micheli et al., 2012; Turner, 2000). However, this prior research is predominantly based on case study results rather than more large-scale survey data (the only exception is Gemser et al., 2011) and has not examined how designer decision freedom may affect important process outcomes such as development speed and budget.

To examine the influence of these factors, we conducted a study of 83 design innovation projects that were launched in the market between 2009 and 2013. We collected data on projects for which companies hired external design consultancies to develop a new product or service. We surveyed two respondents per project: the senior external designer and the project manager at the client's side. We thus include the viewpoints from two essential informants (Bruggen, Lilien, & Kacker, 2002), which reduces common method bias (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003).

With our study, we contribute to the existing literature in the following ways. First, we investigate exploration and exploitation activities for design innovation rather than for

technical innovation, which has been the focus of prior studies (Atuahene-Gima & Murray, 2007; Kim & Atuahene-Gima, 2010; Kyriakopoulos & Moorman, 2004; Molina-Castillo et al., 2011; O'Cass et al., 2014). Second, we show the differential effects of exploration and exploitation activities on design innovation and its outcomes. Although prior research suggests that exploration and exploitation activities may have different roles in innovation projects (Danneels, 2002), there are only few empirical studies that actually demonstrate that exploration and exploitation activities have differential effects (Kim & Atuahene-Gima, 2010; Molina-Castillo et al., 2011; O'Cass et al., 2014) and those available focus on technical innovation rather than design innovation, as we do in this paper. Specifically, we find that exploration activities enhance design innovation and exploitation activities moderate the relation between design innovation and process performance in such a way that this relation is positive (negative) when exploitation activities are high (low). Third, we show the influence of designers' decision freedom on outcomes, and show the differential effects of this freedom on process and market performance. More specific, our results suggest that decision freedom enhances the positive relation between exploration and design innovation. We also find that when designers have high (low) levels of decision freedom, the relationship between design innovation and market performance is negative (positive), while the relationship between design innovation and process performance is positive (negative). On the basis of our results, better managerial decisions can be made regarding investments in design innovation and how to manage it to optimise outcomes.

The remainder of this paper is structured as follows. First, we review the relevant literature and present our hypotheses, after which we explain our method. Next, we discuss our findings. We conclude by discussing multiple implications for theory and managerial practice, and provide directions for future research.

Theoretical framework

This paper defines design innovation not only in terms of newness of products' appearance, but also in terms of newness in the emotions that products evoke and the way they enable customers to express their identity. There is increasing recognition in the marketing/innovation field of the ability of design to influence not only aesthetic experiences, but also symbolic and emotional experiences (Candi, Beltagui, & Riedel, 2013; Homburg, Schwemmle, & Kuehnl, 2015; Verganti, 2008). For instance, Homburg et al. (2015) identified symbolism (i.e. the perceived message products communicate regarding a consumer's self-image) as an important dimension of product design, next to appearance and function. While prior research has focused in particular on examining the influence of new aesthetics on market outcomes (Landwehr et al., 2013; Rubera, 2015; Talke et al., 2009), there is also some evidence that design generating innovative symbolic or emotional experiences can have a significant impact on market success (Gemser et al., 2011).

Overall, prior research on design innovation predominantly focussed on investigating consequences, be it in terms of aesthetics experiences or other types of outcomes (Gemser et al., 2011; Gemser & Leenders, 2001; Korenok et al., 2010; Landwehr et al., 2013; Micheli & Gemser, 2016; Rubera, 2015; Rubera & Droge, 2013; Talke et al., 2009). Some of these studies also investigated how the relationship between design

innovativeness and performance is moderated by variables such as branding strategy (Rubera, 2015; Rubera & Droge, 2013), the exposure that consumers had to an innovation (Landwehr et al., 2013), or the national design tradition in a country (Micheli & Gemser, 2016). In this paper, we investigate the effects of exploration and exploitation activities in design innovation projects. Li, Vanhaverbeke, and Schoenmakers (2008) suggest that exploration and exploitation activities reflect the nature of the innovation process rather than the nature of the outcome. We follow these authors' suggestion and define exploration and exploitation activities from an innovation *process* perspective. An innovation process may include both exploration and exploitation activities (Li et al., 2008). Indeed, prior research suggests that exploration and exploitation activities have different roles in the innovation process, and influence different innovation outcomes. Exploration seems to be more important for achieving differentiated and innovative outcomes, while exploitation is more likely to contribute to cost efficiency and profit gains, efficiency in producing the product, and to its quality (Kim & Atuahene-Gima, 2010; Molina-Castillo et al., 2011; O'Cass et al., 2014).

In this paper, we hypothesise that exploration activities influence design innovativeness, and that design innovativeness will have an impact on project performance (see Figure 1). We also hypothesise that the relationship between design innovativeness and project performance will be moderated by exploitation activities, as these activities ensure that the new design knowledge generated by the exploration activities is effectively and efficiently implemented (See Figure 1). Furthermore, we include an important moderator in our analyses: designers' decision freedom. We postulate that the decision freedom of designers will influence the relationship between exploration and design innovativeness. In addition, we postulate that designer freedom will moderate the relationship between design innovativeness and project performance, because giving designers freedom to act will have performance implications. Figure 1 provides an overview of the relationships that we hypothesise and test in this paper. Below, we explain in more depth how exploration and exploitation activities and designer decision freedom play a role in achieving design innovativeness and other outcomes.
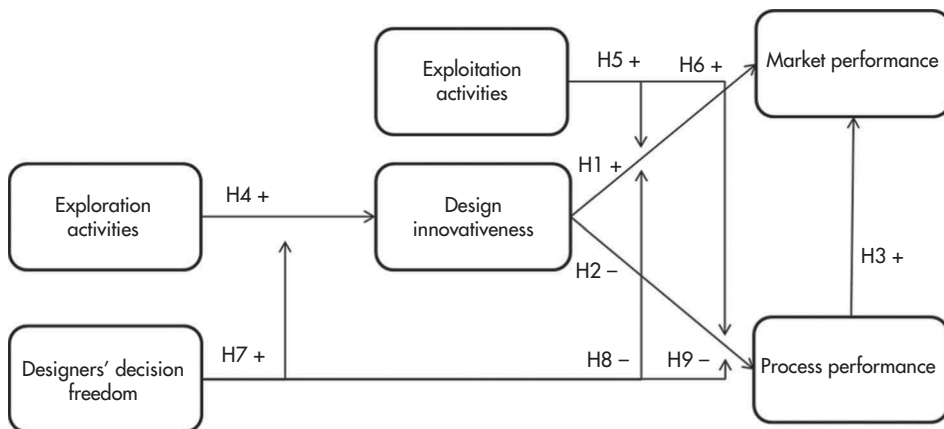

Figure 1. Research model.

Design innovativeness and performance

Prior research suggests that design innovativeness results in higher sales or turnover, or in a growth in market share (Gemser & Leenders, 2001; Korenok et al., 2010; Landwehr et al., 2013; Rubera, 2015; Rubera & Droge, 2013; Talke et al., 2009). Talke et al. (2009), for example, found that design newness, operationalised as the dissimilarity in products' appearance compared with competing products, has a positive influence on automotive sales. The findings of Rubera and Droge (2013) suggest that design innovations (i.e. products with design that is new, original, and patented), when branded using corporate branding, enhance product sales. Rubera (2015) finds that design innovativeness (i.e. the degree of novelty in a products' external appearance) increases sales' growth rates. The results of Landwehr et al. (2013) show that atypical cars (i.e. cars that are dissimilar to a prototypical design in a certain product category) outsell typical cars (those similar to a prototypical design in a certain product category) when consumers had high levels of exposure to these products. Moreover, Gemser and Leenders (2001) show that organisations that pursue a design innovation strategy (i.e. a strategy focused at introducing designs that are different from competing products in terms of aesthetics and usability) experience a growth in turnover. Korenok et al. (2010) find that changes to vehicle styling, both partial (i.e. changes to the grill, tail lamp or partial changes to the vehicle's sheet metal) and complete (i.e. changes to vehicles' entire sheet metal and glasshouses; changes to styling due to a new entrant), have a positive influence on market share growth. Overall, these results suggest that design innovativeness enhances market performance.

H1. *Design innovativeness has a positive influence on market performance.*

Higher market performance from introducing innovative designs may however be counteracted by the higher costs of developing and marketing these radical solutions. Highly innovative designs break with existing standards and may require 'preparing of the ground' so that customers will accept the innovation (Verganti, 2008). For developing innovative designs, companies often integrate designers in the innovation process (Czarnitzki & Thorwarth, 2012). However, as shown by Marion and Meyer (2011), intense use of designers and their methods may result in longer development times. Based on case studies in the fashion industry, Abecassis-Moedas and Benghozi (2012) suggest that design innovativeness comes at the cost of efficiency (in terms of development speed and costs). Using a similar approach in the consumer goods industry, Perks, Cooper, and Jones (2005) show that although involving designers as part of the innovation team is important for radical innovation, it is also time consuming, and the only way to achieve both is to let designers lead the development process. These results suggest that design innovativeness decreases process performance.

H2. *Design innovativeness has a negative influence on process performance.*

Despite this, it is important to keep the cost and time necessary to develop design innovations low, since this stimulates sales (Cankurtaran, Langerak, & Griffin, 2013; Eling, Langerak, & Griffin, 2013; Langerak, Griffin, & Hultink, 2010; Langerak, Hultink, & Griffin,

2008). For example, lower development costs may result in lower product pricing, and lower product prices result in higher sales (Eling et al., 2013). Product sales are also enhanced by new product development speed (Cankurtaran et al., 2013) and by proficiency in market-entry timing (Langerak et al., 2010, 2008). Overall, these results suggest that process performance enhances market performance.

H3.　*Process performance has a positive influence on market performance.*

The role of exploration and exploitation activities in achieving design innovativeness and project performance

Exploration activities are characterised by search, experimentation, and investigation, and can result in new knowledge. This new knowledge, generated through exploration activities, is essential to develop radically new solutions (Atuahene-Gima, 2005). Indeed, prior research shows that exploration activities stimulate the development of product characteristics such as differentiation (Kim & Atuahene-Gima, 2010; O'Cass et al., 2014) and innovativeness (Molina-Castillo et al., 2011). For instance, Kim and Atuahene-Gima (2010) find that explorative market learning (i.e. the acquisition and use of knowledge outside an organisation's current customer and competitor boundaries) has a positive influence on product differentiation. Similarly, O'Cass et al. (2014) show that exploratory product innovation (i.e. the generation of new routines to develop new products) combined with high levels of exploratory marketing (i.e. the generation of new routines to link new products to customers) result in higher levels of product differentiation. Molina-Castillo et al. (2011) find that competence exploration (i.e. activities to acquire new skills and technologies) enhances product innovativeness. We follow these studies, which show that exploration activities stimulate innovativeness in terms of technology, by proposing that their completion also enhances outcomes in terms of design innovativeness. We therefore hypothesise:

H4.　*Exploration activities have a positive influence on design innovativeness.*

Exploration activities are important for design innovativeness, but how successful such solutions are on the market, and the speed, and cost efficiency of their development depends on the extent to which exploitation activities are completed in the project. Exploitation activities help organisations produce and market an innovative solution by using their current competencies (Danneels, 2002). For example, Li (2013) shows that exploitation activities enhance the positive influence of product innovativeness on product superiority (i.e. the extent to which a product's features and functionalities are better than competing product's features and functionalities) and product meaningfulness (i.e. the extent to which a product's features and functionalities are perceived as relevant, beneficial, and useful by customers). Higher levels of product superiority and meaningfulness may make it easier to market an innovative solution. Prior research also suggests that exploitation activities enhance product cost efficiency (Kim & Atuahene-Gima, 2010; O'Cass et al., 2014) and the extent to which products meet manufacturing and performance standards (Molina-Castillo et al., 2011). For instance,

Kim and Atuahene-Gima (2010) find that exploitative market learning (i.e. the acquisition and use of knowledge close to organisations' current customer and competitor boundaries) enhances product cost efficiency. O'Cass et al. (2014) show that exploitative product innovation (i.e. the refinement of existing routines to develop new products) combined with exploitative marketing (i.e. the refinement of existing routines to link new products to customers) results in higher levels of product cost efficiency. Molina-Castillo et al. (2011) find that competence exploitation (i.e. activities to upgrade existing skills and technologies) enhances product quality. Products that are developed in a cost-efficient way and that meet standards are easier and more affordable to manufacture. Overall, these results suggest that a high degree of exploitation activities (i.e. activities completed in the project that involve selecting, implementing, improving, and refining existing certainties) help organisations to produce and market an innovative solution by using their current competencies, resulting in higher levels of performance, both in terms of market and process performance. We therefore propose:

H5.   *Exploitation activities moderate the relationship between design innovativeness and market performance: the influence of design innovativeness on market performance is more positive when exploitation activities are high rather than low.*

H6.   *Exploitation activities moderate the relationship between design innovativeness and process performance: the influence of design innovativeness on process performance is less negative when exploitation activities are high rather than low.*

The role of designers' decision freedom in achieving design innovativeness and project performance

Prior research suggests that involving professional designers in the development process for a new product or service may be an effective way to create design innovations (Dell'Era & Verganti, 2010; Gemser et al., 2011). For instance, Gemser et al. (2011) suggest that more designer involvement results in higher levels of design innovativeness. This research and other studies also suggest that to create design innovations, designers should be given some freedom to act (Beverland, 2010; Gemser et al., 2011; Ravasi & Lojacono, 2005; Venkatesh, Digerfeldt-Manson, Brunel & Chen 2012). Designers' freedom to act results from their authority to make decisions on their own without interference from managers. This is also called designers' decision freedom (cf. Dewar, Whetten, & Boje, 1980). When designers have decision freedom, they can directly influence the nature and outcome of an innovation process. Designers tend to be explorative in nature, future driven, and open to the 'unknown' (Beverland & Farrelly, 2011). Designers are not only adept at exploration, they also tend to excel at condensing large amounts of information generated by exploration activities into, for example, experiential prototypes (Michlewski, 2008). In summary, we expect that designers are well equipped to generate and make sense of new knowledge developed through exploration activities, and to integrate this knowledge into design innovations. We therefore propose:

H7. *Designers' decision freedom moderates the relationship between exploration and design innovativeness: the influence of exploration on design innovativeness is more positive when designers' decision freedom is high rather than low.*

Designers' practices and capabilities are geared towards developing new products and services rather than selling these new products and services to the market, which is the field of marketing (Beverland & Farrelly, 2011; Bruce & Daly, 2007; Chen & Venkatesh, 2013). If new products and services are radically new in terms of design, the ground may need to be prepared before customers are willing to embrace these new offerings. This requires specific activities that may be better performed by marketing specialists rather than design specialists. This suggests that while designer decision freedom is beneficial for design innovativeness, high designer decision freedom may not lead to optimal market success because input from other (marketing) specialists is also needed. In a similar vein, when designers are free to make decisions about innovative designs, they may make decisions based on their wish to create 'iconic' or award-winning designs without wanting to make compromises (Micheli et al., 2012), which may result in increasing costs and development times. We therefore propose:

H8. *Designers' decision freedom moderates the relationship between design innovativeness and market performance: the influence of design innovativeness on market performance is less positive when designers' decision freedom is high rather than low.*

H9. *Designers' decision freedom moderates the relationship between design innovativeness and process performance: the influence of design innovativeness on process performance is more negative when designer freedom is high rather than low.*

Methodology

Data collection

We collected data on projects that involved the collaboration between design consultancies and their clients. These projects are particularly suitable for our research since design consultancies are often hired for design innovations (Abecassis-Moedas & Benghozi, 2012). The data for this study were collected between November 2012 and January 2014.

Based on data provided by several Dutch design associations, we created a list of 227 Dutch design consultancies, in a wide range of firm sizes and design fields. These design consultancies were contacted by phone to ask for collaboration in the research project. In total, 43 (19%) design consultancies agreed to collaborate, which is similar to prior studies (Molina-Castillo et al., 2011). Design consultancies were sometimes hesitant to collaborate since we not only asked a senior staff member of the design consultancy to participate in our research, but also a staff member of one of their clients. After companies agreed to collaborate, we selected relevant innovation projects to study based on three criteria. First, the innovation project had to be completed; second, the project needed to be completed less than 3 years ago; and third, both the responsible

senior designer at the design consultancy and project manager at the client's side (i.e. the developing organisation) had to be available for participation in the study. For each design consultancy firm, two to three projects on average were selected, resulting in a database of 113 projects.

Considering their role in the innovation process, the external senior designer and the project manager were considered to be the most appropriate innovation team members to survey, being knowledgeable about the constructs under study, namely the activities (explorative and exploitative) completed in the project, its content (level of design innovativeness), execution (level of designers' decision freedom), and performance (market and process). Surveying both the external senior designer and the project manager at the client's side allowed us to deal with common method bias, and to include the viewpoints of both essential actors in our research.

The respondents received a link to an online survey by email. One week after sending the link, the informants received a reminder, and after 2 weeks they were called to answer any questions about the research, after which the link to the survey was sent again. Only projects for which both respondents filled in the survey were included in our study, resulting in a data set of 213 responses, which equals 103 matched dyads (for seven projects, we only received answers from one respondent). For 20 projects, the performance data was missing and these projects were therefore excluded from further analysis. Hence, the full sample size is 83 projects. Of these projects, 37 lasted shorter than 1 year (45,7%) and 44 lasted between 1 and 5 years (54,3%) (for two projects the data was missing). Moreover, 49 projects had a development budget that was smaller than 250,000 euros (59.8%) and 33 projects had a development budget larger than 250,00 euros (40.2%) (for one project the data was missing). Lastly, 50 projects concerned product innovations (60.2%) and 33 concerned service innovations (39.8%).

Measures

The Appendix shows the scales and items included in the survey, and the sources of these scales. All items were measured on a seven-point Likert scale. We defined and operationalised market and process performance as the extent to which the innovation met market and process goals. We defined and operationalised design innovativeness as the extent to which the solution diverged from what was already known in the market in terms of appearance, emotions, and the way products enabled customers to express their identity. The exploration activities scale determines the extent to which activities related to searching for, discovering, creating, and experimenting with new opportunities were completed in the project, while the exploitation activities scale measures the extent to which activities related to selecting, implementing, improving, and refining existing certainties were completed in the project. The designers' decision freedom scale determines the extent to which designers had the authority to make decisions without the involvement of the project manager. We controlled for the type of offering that was developed in the projects as the relationships in our model may differ between product and service innovation. The process of service innovation has, for example, been characterised as more ad hoc as compared to product innovation (Dolfsma, 2004; Kelley & Story, 2000), which may influence outcomes.

Analysis

We analysed our data through partial least squares structural equation modelling (PLS-SEM) (Lohmoller, 1989; Wold, 1975) using SmartPLS software version 2.0 (Ringle, Wende, & Will, 2005). This method is useful when the goal is prediction of the dependent variables to develop or extend theory (Hair, Ringle, & Sarstedt, 2011; Hair, Sarstedt, Ringle, & Mena, 2012). Since we aim to develop theory on how exploration and exploitation at the project level plays a role in design innovation, PLS-SEM is the appropriate method to use. Furthermore, PLS-SEM is particularly useful for research that involves small sample sizes (Hair et al., 2011, 2012), indicating that this method is the appropriate choice for our sample of 83 projects. PLS-SEM requires a minimum of 10 times the largest number of structural paths directed at a particular latent construct in the structural model (Barclay, Higgins, & Thompson, 1995). In our model, there is a maximum of six structural paths directed at our latent constructs, indicating that the minimum sample requirements of PLS-SEM are met.

Dealing with multi-respondent data

We collected data from two respondents to deal with issues of common method bias. In this study, we used one approach to investigate whether common method bias is a problem, and two methods to reduce it. We first analysed whether common method bias is a problem by using Harman's single-factor test (Podsakoff & Organ, 1986), which showed that this is not the case since only 16.7% of the variance was explained by the first factor. Second, we took potential common method bias into account in the construction of our survey: our moderating, independent, and dependent variables were separated by questions not belonging to this study (Podsakoff et al., 2003). Lastly, we used strategies proposed by prior research to reduce common method bias by using different informants for dependent and independent variables and by aggregating their answers (Bruggen et al., 2002; Podsakoff et al., 2003). We used the data from the project managers to assess the market and process performance measures as we expected these actors would have a more complete overview of the success of the project. Since both designers and managers were active participants in the projects, we took an average of their answers to reflect the extent to which exploration and exploitation activities were completed, the level of design innovativeness and the level of designers' decision freedom.

Results

As shown in the Appendix, the composite reliability (CR) estimates ranged from 0.81 to 0.93, which are all greater than the threshold level of 0.70 (Bagozzi & Yi, 1988). We examined indicator reliability by studying the outer loadings of all items in the model, which varied between 0.62 and 0.93 (Hulland, 1999). Discriminant validity was evaluated by studying the square root of the average variance extracted (AVE) estimates. As shown in Table 1, values of the square root of AVE for each construct were greater than the highest correlation between that construct and any other construct (Fornell & Larcker, 1981). Additionally, the loadings of each indicator were greater than the cross-loadings

Table 1. Descriptive statistics and correlations (two-tailed).

Variable	Mean	S.D.	1	2	3	4	5	6
1. Market performance	5.33	1.01	*0.86*					
2. Process performance	4.27	1.44	0.33***	*0.77*				
3. Design innovativeness	4.72	1.26	0.18	−0.13	*0.87*			
4. Exploitation activities	4.19	1.10	0.07	0.04	−0.19*	*0.85*		
5. Exploration activities	5.03	1.02	0.01	−0.02	0.52***	−0.31***	*0.80*	
6. Designers' decision freedom	5.22	0.88	−0.02	0.15	−0.07	−0.10	0.23**	*0.76*

***$p < 0.01$, **$p < 0.05$, *$p < 0.10$; scores marked in bold – italic are the square root of the construct's AVE.

with other reflective indicators, giving further indication of discriminant validity (Chin, 1998). Convergent validity was evaluated by using the values for AVE, of which all values were higher than 0.50 (Bagozzi & Yi, 1988).

The predictive power of the model was analysed by using the values for R^2 (see Table 2). The R^2 value for market performance is 0.28, the value for process performance is 0.16, and the R^2 for design innovation is 0.41. Prior research indicates that the research context is essential in determining which R^2 values are satisfactory (Hair, Black, Babin, & Anderson, 2010). In research on performance in design innovation, R^2 values between 0.15 and 0.30 are common (Gemser & Leenders, 2001; Korenok et al., 2010; Landwehr et al., 2013; Rubera & Droge, 2013; Talke et al., 2009). This suggests that in our study, the R^2 values of market performance and design innovativeness are good, and that the R^2 value of process performance can be considered satisfactory.

Similar to Lew and Sinkovics (2013), we used the effect size f^2 to evaluate how each variable influences a dependent variable (Chin, 2010). The effect size of each variable f^2 was computed by using the following formula: $f^2 = (R^2 included - R^2 excluded)/(1- R^2 included)$ (Chin, 2010). An f^2 of 0.02 was considered a small effect size, 0.15 a medium effect size, and 0.35 a large effect size of the variable (Cohen, 1988). Using this formula, we found that design innovativeness has a small

Table 2. Results from the structural equation analysis.

	Model 1: main effects	Model 2: moderators	Model 3: interactions
Dependent: market performance	**0.17[a]**	**0.18**	**0.28**
Process performance	0.37 (3.66) ***	0.36 (3.18) ***	0.37 (3.43) ***
Design innovativeness	0.23 (2.25) **	0.26 (2.43) ***	0.25 (2.57) ***
Exploitation activities		0.12 (1.15)	0.13 (1.39)
Designers' decision freedom		−0.02 (0.25)	−0.09 (0.99)
Design innovation x exploitation activities			0.05 (0.50)
Design innovation x designers' decision freedom			−0.32 (3.43) ***
Dependent: process performance	**0.02**	**0.04**	**0.16**
Design innovativeness	−0.12 (1.32)	−0.10 (1.17)	−0.11 (1.42)
Exploitation activities		0.05 (0.55)	−0.01 (0.07)
Designers' decision freedom		0.16 (1.55)	0.11 (1.20)
Design innovation x exploitation activities			0.27 (2.40) ***
Design innovation x designers' decision freedom			0.27 (2.67) ***
Dependent: design innovativeness	**0.28**	**0.32**	**0.41**
Exploration activities	0.53 (6.36) ***	0.57 (6.98) ***	0.49 (5.98) ***
Designers' decision freedom		−0.21 (2.05) **	−0.15 (1.75) *
Exploration activities x designers' decision freedom			0.31 (4.35) ***

***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.
[a] Bold figures indicate variance explained in endogenous variables.

effect on market and process performance ($f^2 = 0.06$ and $f^2 = 0.02$ respectively), and that the effect of process on market performance is medium-sized ($f^2 = 0.16$). The effect of exploration activities on design innovativeness is large ($f^2 = 0.39$), while the effect of exploitation activities on the relation between design innovativeness and market performance is non-significant ($f^2 = 0.00$) and its effect on the relation between design innovativeness on process performance is small ($f^2 = 0.08$). Finally, the effect of designer decision freedom on the relation between exploration activities and design innovativeness is medium-sized ($f^2 = 0.15$), and its effect on the relation between design innovativeness and market and process performance is small ($f^2 = 0.13$ and $f^2 = 0.09$ respectively).

Lastly, we assessed the validity of the measurement and structural model using Stoner–Geissers Q^2 through blindfolding (Chin, 1998; Geisser, 1975; Stone, 1974). The values for communality-based and redundancy-based Stoner–Geissers Q^2 were greater than zero, suggesting that our model has predictive relevance (Hair et al., 2011, 2012).

Table 2 shows the structural equation modelling results, based on a bootstrapping procedure with 5000 samples (Berghman, Matthyssens, Streukens, & Vandenbempt, 2013). In support of H1, our data show that design innovativeness increases market performance (Model 1: $\beta = 0.23$, $p < 0.05$). The effect of design innovativeness on process performance is negative but non-significant (Model 1: $\beta = -0.12$, $p > 0.10$), which causes us to reject H2. H3 is supported: process performance has a positive influence on market performance (Model 1: $\beta = 0.37$, $p < 0.01$). In support of H4, our results further show that exploration activities enhance design innovativeness (Model 1: $\beta = 0.53$, $p < 0.01$). Exploitation activities do not moderate the relation between design innovativeness and market performance (Model 3: $\beta = 0.05$, $p > 0.10$), which causes us to reject H5. However, the extent to which exploitation activities are completed in the project does moderate the relation between design innovativeness and process performance (Model 3: $\beta = 0.27$, $p < 0.01$). Figure 2 shows that design innovativeness has a negative influence on process performance when exploitation activities are low, and a positive influence when exploitation activities are high, which allows us to accept
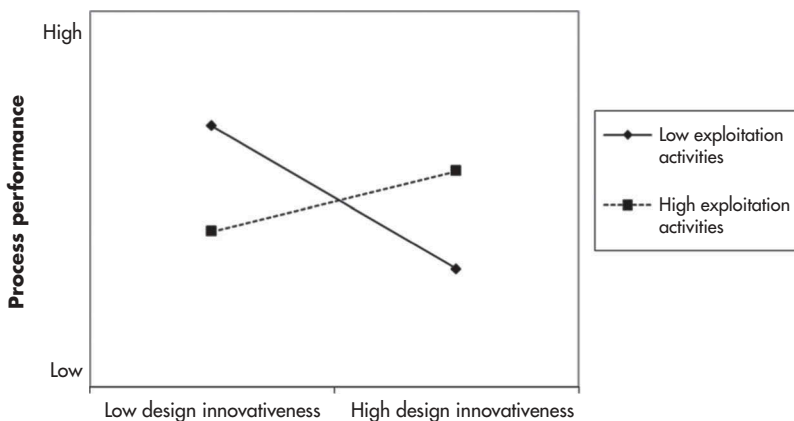

Figure 2. Moderating effect of exploitation activities on the relation between design innovativeness and process performance.

H6. Table 2 further shows that the relation between exploration activities and design innovativeness is moderated by designers' decision freedom (Model 3: $\beta = 0.31$, $p < 0.01$). Figure 3 visualises this effect, showing that exploration activities have a more positive effect on design innovativeness when designers' decision freedom is high rather than low, which allows us to accept H7. Finally, our results indicate that designers' decision freedom moderates the relations between design innovativeness and market performance (Model 3: $\beta = -0.32$, $p < 0.01$) and design innovativeness and process performance (Model 3: $\beta = 0.27$, $p < 0.01$). We accept H8 since our data show that design innovativeness has a negative influence on market performance when designers have high levels of decision freedom, and a positive influence when they have low levels of decision freedom (see Figure 4). H9 is rejected since Figure 5 shows that process performance is positively (negatively) affected by design innovativeness when designers have high (low) levels of decision freedom rather than the other way around as predicted.

Post hoc analysis: comparison between product versus service innovation

We conducted a multi-group analysis to investigate whether the relationships in our model differ for product versus service innovation. Due to sample size restrictions, we conducted this analysis on the model without the designer decision freedom construct. The 83 projects were divided into two groups: products ($n = 50$) and services ($n = 33$). Table 3 summarises the R^2 values of the dependent variables and the PLS estimates of the paths in our model. We compared the product and service innovation group using a parametric approach (Lew & Sinkovics, 2013). Through 5,000 bootstrapping samples, we obtained the standard errors of the paths in the two groups, after which we tested the differences in the path coefficients using t-statistics. Table 3 shows that the differences in the path coefficient between the product and the service innovation groups are not significant.
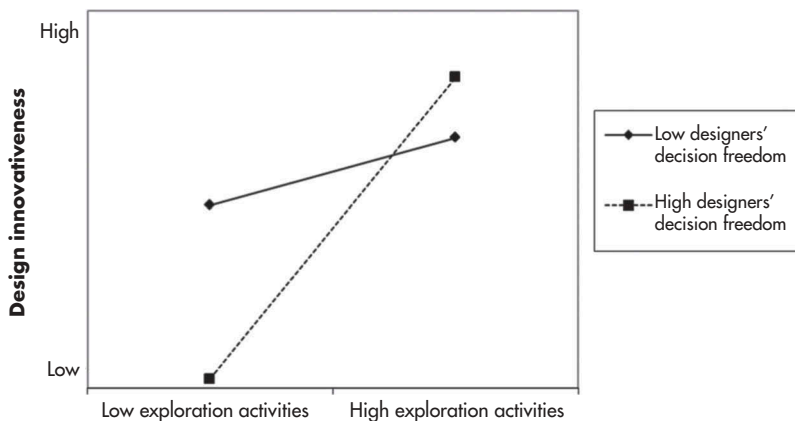

Figure 3. Moderating effect of designers' decision freedom on the relation between exploration activities and design innovativeness.
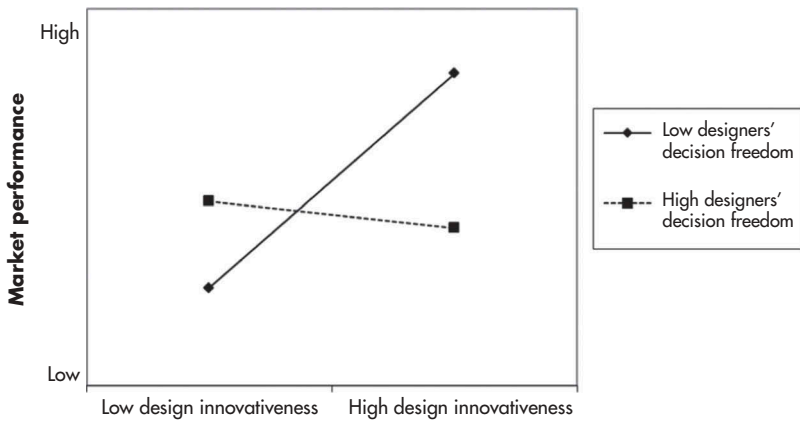
Figure 4. Moderating effect of designers' decision freedom on the relation between design innovativeness and market performance.
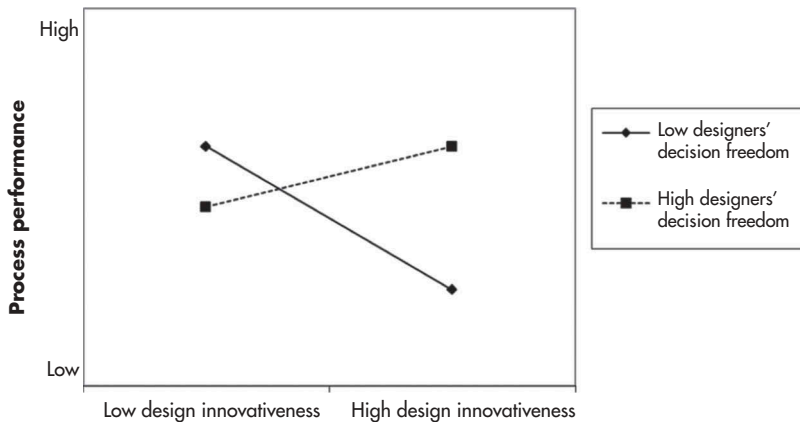

Figure 5. Moderating effect of designers' decision freedom on the relation between design innovativeness and process performance.

Conclusion and discussion

The main objective of this research is to investigate design innovation and its management in terms of the role of exploration and exploitation activities and the decision freedom granted to designers in such projects. More specifically, this research aims to examine the effect of exploration on design innovativeness, and the moderating effect of exploitation on the relationship between design innovativeness and performance. Additionally, we investigate the effect of designers' decision freedom on design innovativeness and other outcomes.

As hypothesised, we find that exploration enhances design innovativeness, and that the effect of design innovativeness on process performance is positive (negative) when exploitation is high (low). However, our results also suggest that exploitation does not moderate the positive relation between design innovativeness and market performance. This may be explained by the fact that when exploration leads to high levels of design

Table 3. Multi-group analysis for product versus service innovation

	Overall model (n = 83)	Product innovation (n = 50)	Service innovation (n = 33)	Difference |PI – SI|	t-Statistic (df = 81)
R^2					
Market performance	0.18	0.28	0.25		
Process performance	0.07	0.22	0.07		
Design innovativeness	0.28	0.35	0.23		
Paths					
Design innov. → market perf.	0.25 ***	0.17	0.36 **	0.19	1.01 (n.s.)
Design innov. x exploitation → market perf.	0.08	0.21	0.14	0.07	0.34 (n.s.)
Design innov. → process perf.	−0.11	0.05	−0.13	0.18	1.16 (n.s.)
Design innov. x exploitation → process perf.	0.23 **	0.42 ***	0.20	0.22	1.02 (n.s.)
Process perf. → market perf.	0.35 **	0.48 ***	0.26*	0.22	1.13 (n.s.)
Exploration → design innov.	0.53 ***	0.59 ***	0.48 ***	0.11	0.80 (n.s.)

***$p < 0.01$, **$p < 0.05$, *$p < 0.10$, n.s.: non-significant. PI: product innovation, SI = service innovation.

innovativeness, the added value of exploitation for market performance is curtailed because activities that involve current knowledge and competences do not fit well with what is needed to market radically new design innovations.

Our data also show that the extent to which designers have the freedom to make decisions on their own moderates the relation between exploration activities and design innovativeness. In particular, we hypothesise and find that when designers have high levels of decision freedom, exploration has a more positive influence on design innovativeness than when they have low levels of decision freedom. Designers' decision freedom also moderates the relation between design innovativeness and performance. As expected, design innovativeness has a negative (positive) influence on market performance when designers have high (low) levels of decision freedom. The moderating effect of designers' decision freedom on the relation between design innovativeness and process performance is different to our hypothesis: we find that this relation is positive (negative) when designers' decision freedom is high (low). This may, perhaps, be explained by the fact that designers, when they can make decisions on their own, tend to do this quickly by using their expert intuition (Beverland & Farrelly, 2011; Lorenz, 1994). Alternatively, designers who are allowed to make decisions on their own may enjoy a higher status in the eyes of the other project team members and will therefore be able to realise their ideas more quickly and cost efficiently.

We contribute to the existing literature in the following ways. First, we examine exploration and exploitation activities in design innovation, as opposed to technological innovation, which was the focus of prior research (Huang & Li, 2012; Kyriakopoulos & Moorman, 2004; Li, 2013). In studies on exploration and exploitation and innovation outcomes, innovation is generally conceptualised in terms of new functionality or technology (i.e. technical innovation). There are no studies known to us that examine exploitation and exploration activities in the context of design innovation. We show that exploration and exploitation activities have different roles in such projects. More specifically, we find that exploration enhances design innovativeness and exploitation moderates the relation between design

innovativeness and process performance. These findings extend prior research on the different roles of exploration and exploitation, which shows that exploration is important to achieve innovativeness (Molina-Castillo et al., 2011) and differentiation (Kim & Atuahene-Gima, 2010; O'Cass et al., 2014), while exploitation assures quality (Molina-Castillo et al., 2011) and cost efficiency (Kim & Atuahene-Gima, 2010; O'Cass et al., 2014). Moreover, our results answer recent calls for more research on the influence of exploration and exploitation activities on the degree of innovativeness of the outcome (Li et al., 2008). Second, our findings contribute to the literature on managing exploration and exploitation activities at multiple levels in the organisation (Andriopoulos & Lewis, 2010). Our findings may help individuals to balance more consciously these activities in their day-to-day work, by choosing whether to engage in exploration or in exploitation activities depending on the desired outcomes of the innovation projects. Moreover, our findings may also help to manage exploration and exploitation activities at the organisational level. By ensuring that both types of activities are completed over a portfolio of innovation projects, organisations can ensure their long-term adaptability as well as short-term survival (Andriopoulos & Lewis, 2010). Third, we show how designers' decision freedom influences design innovativeness and other outcomes. Prior research focused on how designers' decision freedom moderates the relation between investments in design and design innovation (Gemser et al., 2011). We extend these findings by showing the moderating effect of designers' decision freedom on the relation between exploration and design innovativeness, and design innovativeness and performance.

Our study offers several guidelines to help managers develop successful design innovations. First, the findings underscore the necessity for managers to undertake both exploration and exploitation activities in design innovation projects. Second, as the two activities have different roles, managers should keep in mind that exploration enhances design innovativeness while exploitation assures the development of such solutions on time and within budget. Finally, managers should keep in mind that the degree to which they give designers the freedom to make decisions on their own influences the level of design innovativeness of the outcome as well as its performance. While high levels of freedom are most appropriate to achieve high levels of innovativeness, managers face a trade-off between market and process performance. Deciding between these two outcomes is important as it relates to effective and efficient use of resources.

This research has some limitations, which give rise to avenues for future research. First, our sample size is relatively small. Although PLS-SEM is the appropriate choice when dealing with small sample sizes, there are also limitations to using this method. Specifically, PLS-SEM produces biased estimates and it does not provide a global measure of goodness of model fit (Hair et al., 2011). We decreased the bias in our estimates by ensuring that our sample size meets PLS requirements and by increasing the number of items for each of our constructs (Hair et al., 2011). Moreover, the results show that our model has predictive power and relevance, providing indication of model fit. Nevertheless, future research may want to confirm our findings by, for example, using a larger data set and/or covariance based structural equation modelling (CB-SEM). Future research may also explore some of our findings more in depth by using qualitative methods. For instance, it may be interesting to study how designers help to balance exploration and exploitation activities in design innovation, as our findings

suggest that both types of activities are important in such projects. Furthermore, future research may investigate why decision freedom is important to achieve high levels of process performance, as this findings goes against what we hypothesised.

Second, we collected data from two respondents to deal with potential issues of common method bias. Even though the results suggest that common method bias is not a problem in our study, its existence cannot be completely ruled out. In addition, our research uses subjective measures of design innovativeness and performance. Respondents may however overestimate the innovativeness and performance of outcomes (Podsakoff et al., 2003). To deal with this issue, we aggregated the answers from our two different types of respondents (i.e. designer and project manager) to reflect design innovativeness and we used the answers from the most knowledgeable respondent to reflect performance (i.e. the project manager). The mean and standard deviation of design innovativeness and performance suggest that overestimation of outcomes is not a severe problem in our study. Nevertheless, future research might want to repeat our research with objective measures of design innovativeness (e.g. design patents) and performance (e.g. actual sales figures, development costs and times).

Our post hoc multi-group analysis suggest that our results do not differ for product and service innovation models when examining the role of exploration and exploitation activities. Future research is, however, necessary to investigate whether the influence of other factors influencing design innovation (outcomes) – including designers' decision freedom – do have a differential impact depending on whether new products or services are being developed.

A final avenue for future research relates to the use of internal versus external designers. Our research focused on design innovations resulting from collaborations with external designers. It would be interesting to study whether our findings are generalisable to exploration and exploitation activities within organisational boundaries, in particular since it may be hypothesised that internal designers may have more affinity with a project's viability and feasibility aspects than external designers.

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Disclosure statement

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Appendix.

Reliability and validity of measures.

Construct and source	Measurement	Mean	S.D.	Loading
Market performance (adapted from Griffin & Page, 1993) (CR = 0.90, AVE = 0.74)	The product attained its unit sales goals	4.51	1.38	0.77
	The product achieved a high level of customer satisfaction	5.63	1.04	0.90
	The product achieved a high level of customer acceptance	5.56	1.17	0.91
Process performance (adapted from Griffin & Page, 1993) (CR = 0.81, AVE = 0.59)	The development costs of the product stayed within the budget	4.35	1.74	0.79
	The product was launched on time	4.32	1.88	0.88
	The product had a short 'time-to-market'	4.09	1.89	0.62
Design innovativeness (adapted from Gemser et al., 2011) (CR = 0.91, AVE = 0.76)	The appearance of the product represented something new or different in the industry of my firm	5.19	1.34	0.85
	The product evoked new or different emotions from customers, emotions that had never before been evoked by products in the industry of my firm	4.75	1.40	0.93
	The product provided customers with a new or different way to express their identity, a way that had never before been provided by products in the industry of my firm	4.18	1.59	0.84
Exploitation activities (adapted from Mom, Van Den Bosch, & Volberda, 2007) (CR = 0.93, AVE = 0.72)	Activities that could be carried out as routine by my firm	4.32	1.35	0.92
	Activities in which my firm has accumulated a great deal of experience	3.58	1.26	0.87
	Activities that my firm clearly knew how to conduct	4.23	1.33	0.82
	Activities that could be properly conducted by using the present knowledge of my firm	4.27	1.25	0.85
	Activities that clearly fitted into the existing company policy of my firm	4.72	1.21	0.79
Exploration activities (adapted from Mom et al., 2007) (CR = 0.90, AVE = 0.64)	Activities in which the products or processes of my firm were strongly renewed	5.27	1.14	0.62
	Activities that required a degree of adaptability from my firm	4.96	1.33	0.88
	Activities that included the acquiring of new knowledge or skills for my firm	5.08	1.26	0.87
	Activities that were not clearly existing company practice for my firm	5.02	1.26	0.90
	Activities that involved searching for new possibilities with respect to the products, processes, or markets of my firm	4.76	1.40	0.70
Designers' decision freedom (adapted from Dewar et al., 1980) (CR = 0.85, AVE = 0.58	I needed to get permission from the project manager every time I wanted to do anything[a]	4.92	1.17	0.83
	The project manager strongly discouraged me from making my own decisions[a]	6.00	0.90	0.70
	Even small matters had to be referred to the project manager for a final answer[a]	5.25	1.27	0.83
	Any decision I made needed to be approved by the project manager[a]	4.58	1.27	0.69

[a]We reversed this item to reflect designer freedom.