

LIGHTING USE AND EVALUATION IN APARTMENT FAMILY ROOMS WITH VARIOUS LAMP TYPES AND COLOURS

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ABSTRACT

A survey of the actual state of possession, setting, use, and evaluation of lamps in family rooms was conducted for 458 apartments in 111 buildings during 2012 and 2013 in Osaka, Japan. Evaluation included items of light environment evaluation of family rooms: brightness, glare, preference, comfort and performance and colours of light, and so on. Impressions of the room were reported by 18 scales comprising three factors of comfort, luxury, and simplicity. Light environment evaluations other than preferences did not differ among those of incandescent, fluorescent, and LED lamps. However, incandescent lamps were more preferred in light environment evaluations. Rooms with incandescent lamps were regarded as more 'comfortable', 'fashionable', 'warm', and 'active' than those without incandescent lamps. No difference was found in either light environment evaluation or impression evaluation between rooms with only 'yellow' LED lamps and those with only incandescent lamps.

Keywords: subjective evaluation, lighting environment, LED lamp, incandescent lamp

1. INTRODUCTION

Lighting environments in dwellings have changed in two ways recently in Japan. First, LED lamps with long durability and high efficacy have spread rapidly in the past several years. Some lighting device manufacturers have chosen to stop producing incandescent lamps. Moreover, electricity power shortages related to the severe accident at the Fukushima nuclear power plant caused by the Tohoku earthquake disaster possibly affected lighting use. The widening use of LED lamps is also partly related to electricity conservation trends.

Sato et al. (1995) surveyed the actual state of lighting possessed by households and clarified the relation of household income and the ratio of incandescent lamps using a questionnaire survey. Kato et al. (1998) clarified that the numbers of fluorescent lamp fixtures were greater than those of incandescent fixtures in family rooms, kitchens, and bedrooms.

The present study investigates the relation between lamp types and colours and the evaluations by a questionnaire survey of apartments in 2012 and 2013. Occupants' evaluations of family rooms with incandescent, fluorescent, and LED lamps were assessed.

2. METHODS

A survey was conducted for apartments in urban areas of Osaka during 2012 and 2013. Of 6,797 questionnaire sheets delivered to 111 apartment building posts, 458 were returned by mail. Rental apartments were excluded because occupants were unable to arrange the lighting devices according to their preferences. The lighting use and evaluation in family rooms were surveyed in detail because various living activities might take place under various lighting devices by various household members. The number, setting condition, lighting area and frequency of use of lighting devices were surveyed for various actions, type, colour, and wattage of lamps. Related attributes of apartments, family rooms, and respondents were also surveyed. Light environments were evaluated in both daytime and night time. The relations between lamp types and evaluations at night time were assessed.

3. RESPONDENTS AND LAMPS

Table 1 presents attributes of family rooms, apartments, and respondents. Mean areas of surveyed apartments were 75.7 m². The mean area of surveyed family rooms was 21.6 m². 72.1% family rooms were LDK type, with the living room, dining room, and kitchen arranged in one room. The mean number of household members was 2.51. Occupants with the

longest residence among family members were asked to respond. Respondents' mean age was 56.0 years. Of the respondents, 76.0% were female.

Of the respondents, 23.0% had only one lamp in the family room. 51.3% had plural lamps but did not use them locally. 25.2% used local lighting. Table 2 shows the inclusion relation of lamp types and colours in surveyed family rooms. Results show that 12.1% had only incandescent lamps, 51.8% had only fluorescent lamps, and 11.8% had only LED lamps in the family rooms. Of the respondents, 23.4% had LED lamps in family rooms. 11.6% had only 'yellow', 39.5% had only 'white', 4.7% had only 'blue-white', and 9.2% had both 'yellow' and 'white' lamps.

4. LIGHT ENVIRONMENT EVALUATION OF FAMILY ROOMS

4.1 Lamp types and evaluation

Figure 1 presents the relation between lamp types and light environment evaluations. Rooms with incandescent lamps ($n=126$) were more preferred than those without incandescent lamps ($n=297$) ($p=0.0083$), but no difference was found in light environment evaluations between rooms with fluorescent lamps ($n=311$) and those without fluorescent lamps ($n=112$). No difference was found between rooms with LED lamps ($n=99$) and those without LED lamps ($n=324$). No difference was found among rooms in which all lamps were incandescent lamps ($n=51$), those in which all only lamps were fluorescent lamps ($n=219$), and those in which all lamps were LED ($n=50$).

4.2 Lamp colours and evaluation

No difference in light environment evaluation was found between rooms in which all lamps were 'yellow' or 'yellow-white' ($n=160$ in total) and rooms in which all lamps were 'white' or 'blue-white' ($n=192$ in total).

4.3 Lamp types and colours

Combinations of lamp types and colours were also investigated. No difference was found in light environment evaluations between those for rooms in which all lamps were 'yellow' LED lamps ($n=23$) and those for rooms in which all lamps were incandescent lamps ($n=30$). No difference was found between rooms with only 'white' LED lamps ($n=16$) and rooms with only fluorescent lamps ($n=116$).

5. IMPRESSION EVALUATION OF FAMILY ROOMS

5.1 Lamp Types

Figure 2 shows the difference of room impression evaluation by possession of incandescent lamps. Rooms with incandescent lamps ($n=126$) were evaluated as more 'comfortable' ($p=0.0019$), 'fashionable' ($p=0.0037$), 'warm' ($p=0.0046$), and 'active' ($p=0.0068$) than those without incandescent lamps ($n=297$). Rooms with only one incandescent lamp ($n=51$) were evaluated as more 'active' ($p=0.0035$) than those without incandescent lamps ($n=297$). It can be said that the impression of the room was improved if only one incandescent lamp existed in the room. However, no differences in impression evaluations were found between rooms with fluorescent lamps ($n=311$) and those without fluorescent lamps ($n=112$). No difference was found in impression evaluation between rooms with only fluorescent lamps ($n=219$) and those without fluorescent lamps ($n=112$).

Figure 3 presents differences of room impression evaluations according to the presence of fluorescent lamps. Rooms with fluorescent and other lamps ($n=92$) were evaluated as more 'calm' ($p=0.0074$) and 'warm' ($p=0.0094$) than those with only fluorescent lamps ($n=219$). No difference was found, however, between rooms with LED lamps ($n=99$) and those without LED lamps ($n=324$), and between those with only LED lamps ($n=50$) and those with LED and other lamps ($n=49$).

Figure 4 portrays the difference of room impression evaluations between incandescent lamps and fluorescent lamps. Rooms with only incandescent lamps ($n=51$) were evaluated as more 'active' than those with only fluorescent lamps ($n=219$) ($p=0.0077$). No difference was found between rooms with only incandescent lamps ($n=51$) and those with only LED

lamps ($n=50$), and between rooms with only fluorescent lamps ($n=219$) and those with only LED lamps ($n=50$).

5.2 Lamp Colours

Figure 5 portrays the difference of room impression evaluation between 'yellow' and 'white' lamps. Rooms with only 'yellow' lamps ($n=49$) were evaluated as more 'warm' ($p=0.0006$), 'fashionable' ($p=0.0011$), 'relaxing' ($p=0.0019$), 'calm' ($p=0.0022$), 'comfortable' ($p=0.0046$), 'balancing' ($p=0.0064$), 'luxurious' ($p=0.0078$), and 'active' ($p=0.0086$) than those with only 'white' lamps ($n=167$).

5.3 Lamp Types and Colours

No difference in room impression evaluations was found between rooms with only 'yellow' or 'yellow-white' LED lamps ($n=23$) and those with only incandescent lamps ($n=30$). No difference in evaluations was found between rooms with only 'white' LED lamps ($n=16$) and those with only fluorescent lamps ($n=116$).

6. CONCLUSION

1-1) Light environment evaluation of brightness, glare, comfort, and performance did not differ among incandescent, fluorescent, and LED lamps. However, rooms with at least one incandescent lamp present were more preferred by respondents. 1-2) The light environment was evaluated as more preferred when lamp colours of all lamps were 'yellow' rather than 'white'. 1-3) No difference was found in light environment evaluation between rooms with only 'yellow' LED lamps and those with only incandescent lamps. 2-1) Rooms with incandescent lamps were evaluated as more 'comfortable', 'fashionable', 'warm', and 'active' than those without incandescent lamps. No difference in impression evaluation was found between rooms with and without fluorescent lamps and between those with and without LED lamps. 2-2) Rooms with only 'yellow' lamps were evaluated as more 'warm', 'fashionable', 'relaxing', 'calm', 'comfortable', 'balancing', 'luxurious', and 'active' than those with only 'white' lamps. 2-3) No differences in room impression evaluations were found between rooms with only 'yellow' or 'yellow-white' LED lamps and those with only incandescent lamps.

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Table 1 Frequency of Lamp types and colours

		Possession	Frequency	(%)
Lamp types	C-lamps	With Only C-lamps	51	12.1%
		With C-lamps and others	75	17.7%
		Without C-lamps	297	70.2%
	F-lamps	With Only F-lamps	219	51.8%
		With F-lamps and others	92	21.8%
		Without F-lamps	112	26.5%
LEDs	With only LED lamps	50	11.8%	
	LED lamps and others	49	11.5%	
	Without LED lamps	324	76.8%	
	Lamp colors	Only 'yellow'	49	11.8%
		Only 'white'	167	39.5%
Only 'blue-white'		20	4.7%	
'Yellow' & 'white' ^{※1}		39	9.2%	
Only 'yellow' to 'white' ^{※2}		160	37.8%	
Only 'white' to 'blue' ^{※3}		192	45.4%	
'Yellow'-'white' & 'white'-'blue' ^{※4}		71	16.8%	

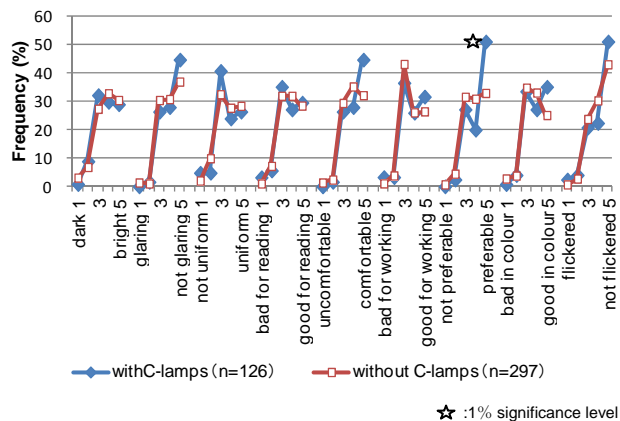


Figure 1 Incandescent lamps and light environment evaluation

