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Airconditioning in Australia II - User Attitudes

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An earlier paper by the authors (ASR, Vol. 29, No. 3, September 1986) *presented thermal comfort responses of large samples of office workers to the immediate thermal environments in Darwin, Brisbane and Melbourne air-conditioned buildings. The current paper reports the same building occupants' attitudes on airconditioning and indoor climate-related issues. The results are related to energy conservation, "sick building" hypotheses and man-environment systems theory.*

Introduction

In buildings, where large groups of occupants are required to share spaces [such as those with open-plan offices], it has become necessary to place the control of internal environments exclusively in the hands of building services engineers, who have become rather like "zoo-keepers". The practice of airconditioning in this context has been guided by large scale ergonomic research programmes in both Europe and the United States. Up until the mid-seventies, in an era of cheap energy, the objective of such programmes was simply to identify the optimally comfortable thermal conditions for samples of subjects sitting in tightly controlled climate chambers. By elaborating the interactions between key indoor climatic parameters in terms of human heat balances or physiological thermoregulation, it was possible for ergonomic specialists to furnish the airconditioning industry with supposedly universally applicable design and operational standards (Refs. 1 and 2). Less intensive research has so far been undertaken on indoor air quality, but this has also been addressed by authoritative standards (Refs. 3 and 4).

Despite these efforts to maximize occupant comfort and satisfaction with indoor climate, the "success rate" of airconditioning practice to date has been less than one might have expected. In Australia this is indicated in a statement by the National Secretary of the country's largest white-collar union that, after salaries and conditions, the most frequent complaints by office workers concern inadequate ventilation and thermal discomfort (Ref. 5).

The response of building managers to an outbreak of occupant complaints [sometimes referred to as the "sick building" syndrome] has been to check the airconditioning system for compliance with the relevant indoor climate standards. More often than not it is found that the required volume of fresh air has been delivered to the occupied space (Ref. 6). Indeed, despite more than 500 epidemiological investigations of sick building cases in America and Europe, reports clearly identifying an environmental cause and an effective correction are extremely rare (Refs. 7 and 8).

In the same way that epidemiologists' investigations have failed to establish any simple dose-response relationships between indoor air pollutants and sick building symptoms, several field investigations of thermal comfort have failed to support the simplistic stimulus-response notions embodied in comfort standards (Refs. 9 and 10). Consequently, several authors have suggested the importance of psychological factors in the sick building and thermal comfort contexts, such as perceived control of microclimate (Refs. 7,8,11,12 and 13).

Another psychological variable considered in the more recent comfort literature is occupant expectation of their indoor climate, which is hypothesised to act as a criterion for determining the degree of satisfaction with the building (Ref. 14). Such a hypothesis has some empirical support from the London office building

surveys of Black and Milroy (Ref. 15). Despite the greater variability in microclimatic conditions that they found in non-airconditioned buildings as opposed to airconditioned buildings, occupants of the latter expressed more complaints about temperature fluctuations. It would seem as if the occupants had a preconception of what airconditioning should achieve, and based their evaluations on this benchmark instead of what airconditioning could actually provide. In effect, increasing levels of sophistication in environmental control systems and building services are on a treadmill of attempting to satisfy ever-increasing occupant expectations.

Aims

The earlier report in this journal (Ref. 10) detailed the comfort responses of Australian airconditioned building occupants to their immediate thermal environments. The purpose of the current paper is to supplement those data with information on occupant attitudes and other psychological factors relating to indoor climate and airconditioning. To further enable the testing of various hypotheses, comparable data were also collected from similar populations of non-airconditioned building occupants:-

1. The current study presents data on two key dimensions of attitude (Ref. 16) towards airconditoning : beliefs and preferences.
2. Health and airconditioning issues are examined in relation to current hypotheses on the sick building syndrome.
3. The influence of occupants' thermal histories on their indoor climate-related attitudes are investigated.
4. Finally, an investigation is made of the building occupants' overall thermal evaluations of their workplace and the relationships of these to physical microclimatic conditions in their buildings.

Methods

Airconditioned building occupant surveys were conducted in three climatically disparate cities of Australia; two surveys in equatorial Darwin (one during the most climatically stressful season just prior to the onset of the wet season which is referred to as the "Build-up", and the other during the "Dry" season); one airconditioned survey in sub-tropical Brisbane during the summer; and another in mid-latitude Melbourne, also during the summer. For comparative purposes, two samples of non-airconditioned building occupants were also taken in Brisbane and Melbourne, both during the summer. Table 1 gives statistical summaries of the outdoor weather conditions prevailing during each airconditioned (AC) and non-airconditioned (NAC) survey period.

Table 1

Outdoor Meteorological Conditions during the Six Surveys

		Darwin AC		Brisbane		Melbourne	
Measurement		The Dry	Buildup	AC	NAC	AC	NAC
Office hours outdoor temp.	Mean	27.9	30.6	27.1	27.2	21.1	23.7
	Stdev	2.3	1.8	1.6	1.9	4.8	8.5
	Sterr	0.11	0.08	0.07	0.08	0.21	0.36
	Range	11	12	10	7	29	29
Outdoor relative humidity (%)	Mean	38%*	66%*	52.8%*	56.7%	50.4%	38.6%
	Stdev	NA	NA	8.3	6.7	15.4	16.5
	Sterr	NA	NA	0.36	0.35	0.68	0.70
	Range	NA	NA	60	46	86	79
Office hours part. vapour pressure outdoors (mmHg)	Mean	10.6*	22.0*	14.6*	15.8*	9.7*	8.8*
Mean monthly outdoor temperature		25.0	28.8	24.4	25.0	20.0	20.0

*Calculated from mean office hours outdoor dry - and wet-bulb temperatures
AC = Airconditioned
NA = Data were not available
NAC= Not airconditioned
Stdev = Standard deviation
Sterr = Standard error

The buildings used in the six surveys were all occupied by clerical or administrative workforces. The difficulties of securing permission from employers to conduct such a survey prevented a completely random sample of office buildings being executed, so the final selection of buildings was based upon the advice of each city's administrative officer responsible for government office-space. These officers were asked to compile a representiative cross-section of government accommodation. In Darwin, 14 airconditioned buildings were investigated. In Brisbane, 5 airconditoned and 5 non-airconditioned buildings were studied, while in Melbourne there were 4 airconditioned and 3 non-airconditioned buildings in the selections.

The researchers drew a simple random sample of respondents within each selected room, on the basis of a floor-plan of numbered work-stations and a table of random numbers Table 2 contains brief biographical details of the samples of respondents.

Table 2

Biographical Charasteristics of the Six Samples

	Darwin AC		Brisbane		Melbourne	
Characteristic	The Dry	Buildup	AC	NAC	AC	NAC
Number of respondents	174	197	211	218	186	194
Percentage females	57%	53%	48%	48%	34%	38%
Percentage males	43%	47%	52%	52%	66%	62%
Median age (yrs)	31	32	29	26	31	27
Mean length of residence in survey city (yrs)	9	10	18	19	24	21

The methods of obtaining instantaneous thermal comfort and sensation responses as well as the indoor microclimatic measurement procedures have been detailed in the earlier paper (Ref. 10). The questionnaires used in the current research employed a variety of item formats, but broadly, the instrument followed the design principles set out in Oppenheim and Hymen (Refs. 17 and 18). Following the attitude questionnaire was a battery of factual/biographical questions. The schedules were pilot tested with small groups of Darwin public servants and Brisbane university students and, in their final form, took approximately 20 minutes to complete.

Results

Free-Answer Beliefs About Airconditiong in the Workplace

Respondents of all six surveys were asked open-ended questions concerning what they believed the advantages and disadvantages of airconditioning to be. The current paper focuses on the latter.

Disadvantages

The coding of the free-answer disadvantages yielded nine clearly identifiable classes of response and one miscellaneous category, as depicted in Figure 1. The height of each bar in the graph represents the percentage of all total possible responses in each survey that fell within the coding category. The question was asked three times of each respondent, therefore the possible total or 100% was three times of the sample size. In the case of the two NAC surveys, only those respondents who claimed to have previously worked in an AC building were questioned on the matter (81 people in Brisbane and 128 in Melbourne NAC surveys). The percentage of actual responses out of the total possible, was fairly constant in the four AC surveys, between 57% to 61%. The Brisbane NAC respondents volunteered slightly fewer disadvantages (53% of possible answers being given), while the Melbourne NAC respondents gave 63% of possible answers.

One of the most frequently cited disadvantages was the thermal gradient between indoors and outdoors, attracting about 10% of total possible responses in the four AC surveys. Interestingly, the respondents of NAC surveys remembered this disadvantage more frequently than their counterparts currently working in AC buildings. This was most noticeable in Melbourne (16% of all possible responses in this class), where the average indoor/outdoor thermal gradient was comparatively moderate. Possibly the response rate in this category was biased by the memory of the extreme thermal gradients that occur during that city's summer hot-spells [as evidenced by the high standard deviation of outdoor temperatures for that city in Table 1]. Among the types of answers that were coded into this class there were many expressions of concern about the adverse health effects of "thermal shock". As one respondent in Darwin's "Build-up" survey put it:

"I'm sure that plunging your body into arctic conditions after it has been running around in the tropics does no good for it."

Other typical answers in this category included:

"Going in or out of this building knocks me around so much that I have to avoid doing it at lunch time."

"Getting to work, you build up a sweat that just sticks to you in this cold, still environment ... the best way to get a chill."

While many of the complaints about thermal gradients between indoors and outdoors had health implications, Figure 1 indicates that as many as 14% of all possible answers in some surveys referred to other health effects of working in AC. Many related to suspicions about low ventilation rates and the spread of infectious diseases, particularly of the upper respiratory tract. As with the thermal gradient complaint, the respondents in Melbourne's NAC survey who had previously worked in an AC building were most vocal about health risks. Typical comments in this category of complaint were:

"If anyone gets the flu in this place, the whole building gets infected within a fortnight."

"Once you get a cold or the flu, it seems to take ages to shake it off when you work in airconditioning."

"At least half the people in this building seem to have a cold or the sniffles at any one time."

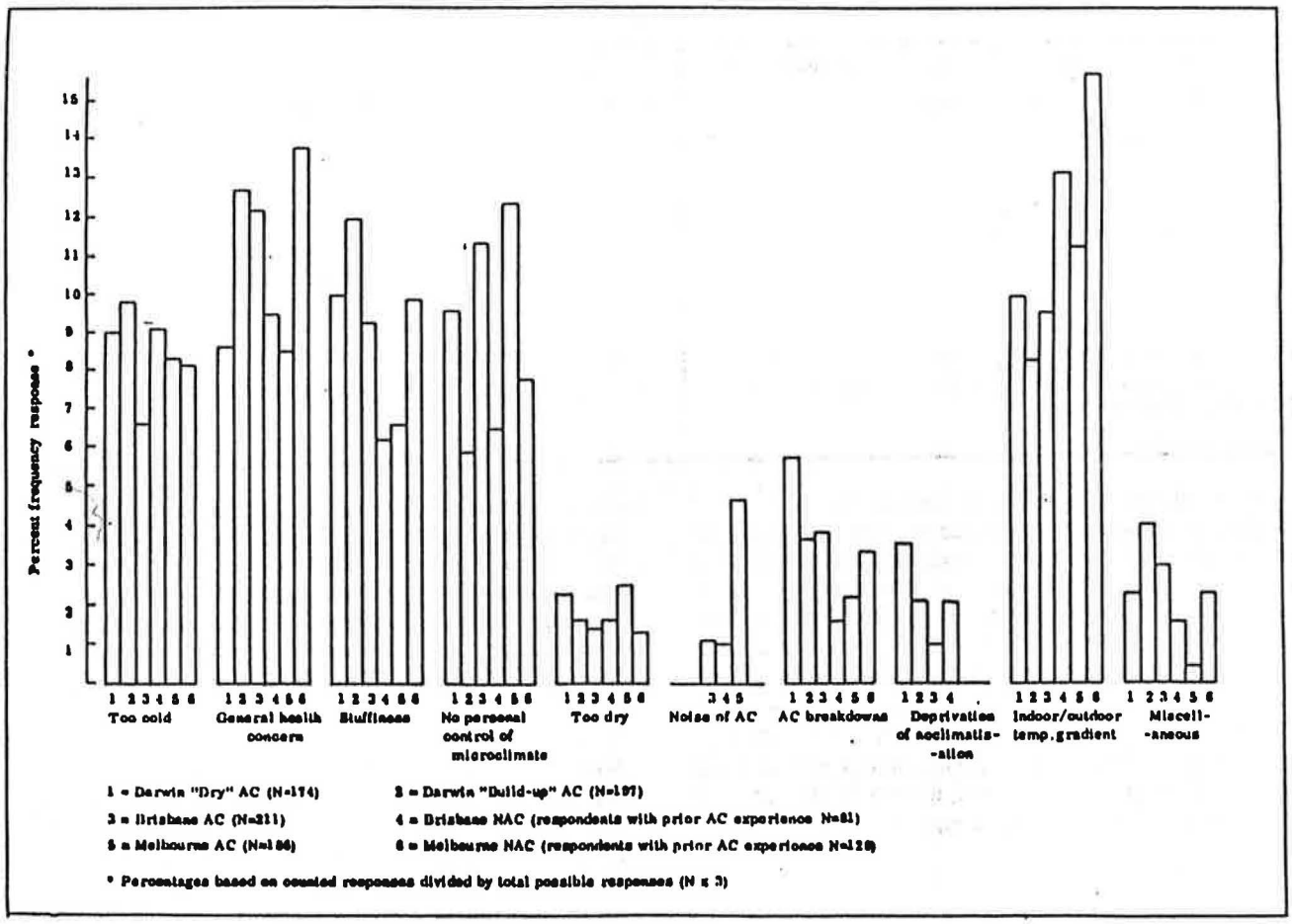

Figure 1. Perceived advantages of air conditioning in the workplace: open-ended responses coded into 10 classes.

Another of the frequently cited grievances with AC in Figure 1 focused on the problem of having no control over microclimatic conditions. Many of the responses in this category referred to spatial and temporal variability in indoor climatic conditions. The Darwin "Dry", Brisbane and Melbourne AC surveys polled in the 10-12% vicinity for this class of complaint, while the percentage of all possible responses falling into this category in Darwin's "Build-up" and the two NAC surveys ranged between 6% and 8%. The following three quotes convey something of the tenor of answers in this category:

"I get rapped across the knuckles if I so much as look at the thermostat."

"The temperature fluctuates wildly from one part of the building to another yet there's nothing we can do about it."

"About all we can do when the system is out of balance is complain to the industrial officer, and then we get accused of being whingers (malcontents)."

In the six surveys betwen 6% and 10% of all potential responses contained a complaint about AC being too cold. Obviously some of these responses overlapped with the "thermal gradient" and "no personal control of microclimate" coding categories, but the following three quotes are representative of the unique responses in this class:

"It's ridiculous that here in the tropics, during the hottest time of the year, we draftsmen have to turn small radiators on to stay warm." (Darwin)

"It always amuses me when I come in here after being boiled outside to see the typists wearing cardigans and legwarmers."

"I suspect the fellow who runs this building's airconditioning system thinks he's short-changing us unless we're actually cold; its always colder than necessary."

The last major classification of airconditioning-related complaints dealt with air quality issues such as passive smoking, stuffiness and ventilation rates. The following comments were typical:

"Every time I come into this building I imagine that something must have died in the airconditioning ductwork."

"They never give enough fresh air in this building and yet they still allow people to smoke in here."

Still more dramatic:

"Sometimes I get so frustrated with the foul air in here that I feel like smashing a window open!"

The remainder of the grievances about AC in Figure 1 were distributed among the following catetories; breakdowns of AC plant, noise of the AC systems, dryness of the conditoned air, deprivation of acclimatisation, and miscellaneous. The breakdown of AC either through power black-outs or plant failure was particularly problematic in buildings with fixed windows. Complaints of the condtioned air being too dry usually related to skin conditions, difficulties with contact lenses and dryness of nasal passages.

Belief in the Adverse Health Effects of Airconditioning

Several of the coding categories used in the preceding section to classify free-answer disadvantages of AC had reference to adverse health effects. Respondents in the Brisbane and Melbourne AC surveys were questioned more specifically on these matters. Table 3 contains these two surveys' responses to the question:

"Do you believe that working in refrigerated AC buildings is bad for your health, or that there is no connection between health and airconditioning?"

As Table 3 shows, less than a quarter of the occupants of AC buildings thought that there was no connection whatsoever between AC and health. Between 40% and 44% of occupants held the opposite belief, that there was a definite causal connection.

Ailments Attributed to Summer Airconditioning

Respondents in the Brisbane and Melbourne AC surveys who believed there was either a definite, or possible adverse health effect of AC were asked for three current or previous symptoms or ailments that they thought were causally linked to their having worked in AC during summer months., The responses were coded into 11 symptom categories plus one miscellaneous

Table 3

Belief in the Adverse Health Effects of Summer Airconditioning

Survey	Definately no connection	Possible connection	Definite connection	Don't know	Total
Melbourne AC survey	48 25.8%	52 28.0%	75 40.3%	11 5.9%	186 100%
Brisbane AC survey	39 18.5%	64 30.3%	93 44.1%	15 7.1%	211 100%

Table 4

Ailments Attributed to Summer Airconditioning

Ailment	Melbourne AC survey		Brisbane AC survey	
Cold or 'sniffles'	57	15.1%	65	13.9%
Nasal or sinus	12	3.2%	41	8.8%
Respiratory infections	37	9.8%	37	7.9%
Headaches	9	2.4%	8	1.7%
Bronchial asthma	6	1.6%	12	2.6%
Dry skin or scalp	16	4.2%	4	0.9%
Rheumatism or aches	2	0.5%	3	0.6%
Thermal "shock" entering or leaving building	3	0.8%	2	0.4%
Hayfever	6	1.6%	10	2.1%
Tiredness	11	2.9%	4	0.9%
Sore eyes	0	0%	5	1.1%
Miscellaneous	54	14.3%	55	11.8%
Total	378	100%	468	100%

class. The frequency of response and associated percentage of possible responses in each of the 12 coding categories are listed in Table 4.

The "colds or sniffles" category attracted the greatest frequency of response, in the region of 14-15% of the possible total. The second most frequent class of ailment was "respiratory infections", with a response rate between 8 and 10%. "Nasal and sinus" problems were mentioned by large numbers of respondents, but there was a considerable difference between the Brisbane (8.8% of total possible responses) and Melbourne (3.2%) surveys. It cannot be established without indoor air quality data whether this between-city difference isn't simply the result of the Brisbane region's greater incidence of hayfever-type ailments.

Stated Preferences for Airconditoned or Free-Running Buildings

The attitude questionnaires used in each of the six surveys included questions on which type of workplaces were considered preferable;

"If given a choice, which would you prefer in summer... Working in an office that had airconditoning? OR Working in an office that didn't have airconditoning?"

To the extent that these stated preferences imply some form of behavioural response, they have been regarded as indicators of the effective component of attitude towards AC. The four Brisbane and Melbourne questionnaires used the same format for the question and the breakdown of responses is presented in Table 5. Because the Darwin surveys were treated differently, their results will be presented separately. Table 5 is arranged so that each survey is represented as the row variable, and is broken down according to whether or not the respondents had experience of working in both AC and NAC office buildings. For example, in the first row of the table, 67 people or 72% of Brisbane's AC sample, who had at some stage earlier worked in NAC offices, stated a preference for AC in summer.

The first noteworthy aspect of Table 5 is the comparison of AC surveys with their NAC counterparts. Disregarding the "Don't knows", and putting those with and those without NAC experience together, there was a clear majority (65.1%) of Brisbane's AC respondents stating a preference for working in AC in summer. The opposite was true of the Brisbane NAC survey, where 58.7% of respondents were in favour of working in NAC buildings. There was a statistically significant difference in the distribution of preferences between the two Brisbane surveys [chi square=30.1, d.f.=1, $p<0.01$]. The same comparison of preferences expressed in Melbourne's AC and NAC surveys yielded the same result; those currently in AC preferred it that way, while those currently in NAC buildings preferred not having AC at work [chi square=20.5, d.f.= 0.001, $p<0.01$].

Table 5

Preferences for Airconditioned or Free-Running Buildings in Brisbane and Melbourne

Respondents		Stated preferences AC	NAC	DK	Total
Brisbane AC survey	Respondents with NAC experience	67 72.0%	24 25.8%	2 2.2%	93 100%
	Respondents without NAC experience	69 59.4%	39 33.6%	8 6.9%	116 100%
Brisbane NAC survey	Respondents with AC experience	32 42.7%	42 56.0%	1 1.3%	75 100%
	Respondents without NAC experience	49 40.5%	70 57.9%	2 1.7%	121 100%
Melbourne AC survey	Respondents with NAC experience	72 64.9%	36 32.4%	3 2.7%	111 100%
	Respondents without NAC experience	40 53.3%	29 38.7%	6 8.0%	75 100%
Melbourne NAC survey	Respondents with AC experience	51 39.2%	77 59.2%	2 1.5%	130 100%
	Respondents without AC experience	23 36.5%	36 57.1%	4 6.3%	63 100%

AC = Airconditioned NAC = Not airconditioned
DK = Don't know

The issue of experience influencing stated preferences was further explored in Table 5 of comparing the responses of people who had worked in both AC and NAC buildings with those of people without such experience. In the Brisbane AC survey, there was no significant difference between the preferences of those without experience of NAC buildings and those of respondents who had previously worked in NAC buildings [chi square=2.2, d.f.=1, p>0.05]. The breakdown for the Brisbane NAC survey in Table 5 also clearly indicates that preferences for AC were unrelated to whether or not the respondent had previously experienced working in AC [chi square=0.1, d.f.=1, p>0.05]. The same result was obtained in Melbourne's AC survey in Table 5 with the difference being statistically insignificant [chi square=0.9, d.f.=1, p>0.05], as was the case in Melbourne's NAC survey [chi square=0.01, d.f.=1, p >0.05]. Thus, while the presence of AC in the survey buildings was related to the preferences of their occupants, exposure of the respondents to the alternative mode of climate control at some earlier stage had no effect on their preference for AC or NAC buildings.

The preferences for AC were investigated for interactions with other components of attitude. The preferences of Brisbane's and Melbourne's AC survey respondents were strongly related to their belief in the adverse health effect of AC. Respondents who held such beliefs were more likely to prefer NAC buildings in summer than were those people who believed there was only a possible, or even no causal connection between AC and health. [Brisbane AC chi square=21.1, d.f.=2, p<0.01; Melbourne AC chi square=32.9, d.f.=2, p<-0.01].

While only 44 people in the Darwin "build-up" survey had previously worked in an NAC office, this lack of experience with passive climate control appears not to have been responsible for the overwhelming preference for AC, because the 44 respondents with such experience had their preferences distributed almost identically to those without [chi square=0.2, d.f.=1, p>0 05].

Since the cooling cycle of AC was in operation all year round in the Darwin buildings, the respondents of both seasons' surveys were asked for a month-by-month breakdown of their preferences. There were no statistical differences between the two surveys' monthly breakdowns, so they have been aggregated into a single diagram (Figure 2).

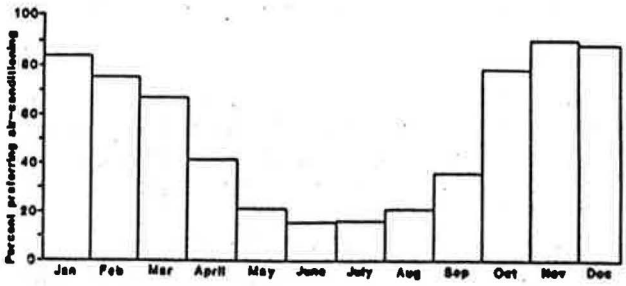

Figure 2: Monthly breakdown of Darwin respondents' preferences for airconditioning in the workplace.

The salient feature of Figure 2 is that the six months from April through September had a majority of the 371 respondents preferring to work in NAC buildings. Only 15% of respondents stated a preference for AC in June. However, the preference for AC peaked at 89% in the "build-up" month of November. Despite comparable levels of outdoor thermal stress in the "shoulder" months of November and April, as measured by the frequency of occurrence of Relative Strain Index values greater than 3 (Ref. 19), the preference for AC dropped by 22% between these two months. This finding is broadly consistent with the hypothesis that acclimatisation and habituation in the intervening "Wet" season mitigated physiological and psychological strain during April.

Overall Impressions of Indoor Warmth

Apart from being asked to give instantaneous assessments on the seven-point scales of warmth of the thermal conditions prevailing at the time of each interview (reported earlier in Ref. 10), respondents were also asked to integrate their recent thermal experiences into an overall impression of the warmth or coolness in their workplace during the season in which the survey was being conducted. These overall impressions were recorded on the familiar seven-point ASHRAE scale of thermal sensation [-3=cold, -2=cool, -1=slightly cool, 0=neurtral, 1=slightly warm, 2=warm, 3=hot], and their summary statistics are presented in Table 6.

Table 6

Overall Warmth Assessments on the ASHRAE Scale

City →	Darwin		Brisbane		Melbourne	
Assessment ↓	"The Dry"	"Build-up"	AC	NAC	AC	NAC
Mean	-1.09	-0.59	0.90	0.60	0.13	1.19
Standard deviation	0.97	1.17	1.23	1.31	1.17	1.43
Standard error	0.07	0.08	0.09	0.09	0.09	0.10
n (total number of people)	172	195	209	198	184	192

As with the instantaneous ASHRAE scale thermal sensation votes (Ref. 10), the overall impressions of indoor warmth in the Darwin "Dry" survey were coolest, with a mean of -1.09, which was significantly different from the -0.59 mean recorded in the next coolest survey, Darwin "Build-up" [t=4.70, p<0.01]. A surprising result

in Table 6 for the Brisbane surveys was that the NAC respondents had a mean overall impression of their buildings' indoor climate during summer [+0.60] that was cooler than their AC counterparts' mean of +0.90 [t=2.38, p<0.01]. This was despite the fact that the mean values for the microclimatic indices recorded in the NAC Brisbane buildings were much warmer than the AC survey values [mean Standard Effective Temperatures were 26.4°C and 23.0°C respectively]. Furthermore, despite the similarity of mean indoor warmth recorded in the two Melbourne surveys [mean Standard Effective Temperatures were 23.2°C and 23.6°C in the AC and NAC surveys respectively], the mean overall impression of warmth in the NAC survey of +1.19 was over one full scale unit warmer than the AC mean of +0.13 [t=7.85, p<0.01]. These data indicate clearly that thermal impressions of building occupants are not solely determined by the typical thermal conditions prevailing in their building.

Summary and Conclusions

It cannot be claimed that the data presented in this paper constitute a fully representative cross-section of the attitudes prevailing in Australia's airconditioned buildings. Indoor climate, ergonomics and other occupational health issues have become sufficiently volatile industrial questions to prevent a strictly random sample ever being executed. While the openness of the Commonwealth and some State Governments in the course of this research project combined with the sheer size of the database [1 180 respondents in all] must minimize any biases resulting from the sampling methods, this caveat should be borne in mind when reading the following conclusions of the study.

1. The negative beliefs about airconditioning recorded in the study emphasized the health issues that are typically associated with the much publicised sick building syndrome. Possibly the sick building syndrome is simply an exaggerated form of the type of health concern expressed in the current surveys. Green and Tromp have elaborated the causal relationships between ambient humidity levels and the susceptibility of the upper respiratory tract [URT] to infection (Refs. 20, 21 and 22). The level of URT mucous flow diminishes and the frequency of micro-fissures in the URT increases with lower ambient humidities. While dehumidification is practiced in the more humid northern climates of Australia, the mean relative humidities recorded in the current surveys were all within the 44-56% relative humidity range, and as such, too high to implicate these physical explanations for the high levels of illness attributed by the survey respondents to airconditioning. Quite probably, the actual incidence of URT infections in airconditioned buildings was not significantly higher than in their non-airconditioned counterparts. Indeed, the recent meeting of the WHO working group on indoor air research (Ref. 23) concluded that;

"...most subtle symptoms reported in connection with sick buildings are not accompanied by positive findings in clinical measurements."

The coincidence of increased frequency of sick buildings with energy conservation programmes in the last decade (Refs.7 and 23) quite possibly relates more to the diminution of occupants' environmental control that accompanies tighter buildings and reduced ventilation rates (Ref.11), rather than any increase of indoor pollutants. As suggested by Stolwijk (Ref.7), when building occupants lose control of their work environment, they tend to blame their "zoo keepers" for any health problems that *might* be environmentally caused. The current data clearly indicate the need for closer examination of this psychogenic hypothesis for airconditioning related health complaints and their more extreme variant, the sick building syndrome.

2. High on the list of complaints about airconditioning was the lack of control that occupants had over their microclimate. Many of the responses in this category conveyed the impression that airconditioned building occupants had become particularly sensitive to and intolerant of subtle temperature variations if those changes were beyond their control. The expectation of constancy in airconditioning seems to play as big a role in determining indoor climatic acceptability as does the actual temperature.

3. The high level of dissatisfaction with the temperature gradient between airconditioned indoors and outside summer temperatures suggests that the proposal to vary HVAC set points in accordance with prevailing outdoor temperatures (Refs. 9, 10 and 24) could meet with significant occupant approval. However, previous experience gained in the implementation of energy conservation strategies emphasizes the need to somehow involve building occupants in any such changes (Ref.24). Radical alterations to indoor temperatures imposed by the "zoo keeper" on an unaware set of occupants are universally greeted with vigorous resistance.

4. Occupants of airconditioned buildings tended to prefer such buildings, while occupants of non-airconditioned buildings preferred not having airconditioning. The latter finding was true of even the hottest passive buildings in Brisbane and Melbourne, and was not simply the result of people being ignorant of the comforts of airconditioning. In the case of equatorial Darwin, there were six months of the year in which airconditioning was considered a necessity by most respondents. However, for the six months from April through September, most of the 371 Darwin respondents would prefer passive buildings. The coolest of these six months (July) was still recording a mean monthly outdoor temperature of 25°C, which was higher than that recorded during the warmest airconditioned survey in the other two cities (Brisbane). While 68% of respondents in the Brisbane airconditioned survey preferred airconditioning, the corresponding figure for the Darwin sample in July was only 18%. Such a large discrepancy despite the comparable outdoor climatic conditions strongly confirms the role of climatic experience in determining subjective assessment of indoor climate. Darwin's July temperatures to most of us would be considered quite warm if not hot, but to Darwin residents who have the stressful humidity of the wet season as their benchmark, the outdoor climate at this time of the

year is mild and airconditioning in the workplace is considered quite unnecessary.

5. The relativity of thermal perception was also evident in the data on building occupants' overall impressions of warmth. Darwin's airconditioned buildings were given the coolest overall ratings despite the mean temperatures in them being comparable to those in Brisbane and Melbourne airconditioned buildings. Possibly it was the benchmark of prevailing levels of outdoor thermal stress that caused indoor climates in that city to be rated so coolly. Brisbane and Melbourne building occupants' overall thermal impressions of their workplace were also dissociated from the actual microclimatic conditions prevailing in their buildings. The warmest buildings surveyed throughout the whole project were the non-airconditioned ones in Brisbane, and yet these were rated overall as being cooler, or at least closer to neutral, than were the airconditioned buildings in the same city.

One possible explanation for this seeming dissociation between subjective and objective warmth could be that the physical measurements of the latter were made on days that were unrepresentative of the season to which the overall subjective warmth question referred. While the exact timing of each set of microclimatic measurements was not randomized, the fact that each survey was spread across 6 to 8 weeks, and that there was about 600 full sets of these physical measurements in each survey (Ref.10) tends to discount this explanation.

These data strongly refute the simplistic stimulus-response notions embodied in contemporary theories and standards for indoor climate. The psychological dimensions of thermal perception and indoor climatic evaulation are in need of closer examination if we are to realize comfortable, yet energy-conserving built environments.

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