Lightning Knowledge and Folk Beliefs in Austria

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Abstract: Atmospheric electricity receives high social attention by lay people, and by mass media. Lightning folk beliefs ("myths") and lay theories on atmospheric electricity can be protective or counter-protective for the general population. Folk beliefs have been enumerated by scientists, but should be systematically assessed because of their importance for individual preventive behavior and for public education campaigns. Austrian environmental psychology started an empirical test of the subject. A questionnaire with 51 items (lightning knowledge, risk awareness, folk beliefs, life-saving cognitions and behavior) and sociodemographic variables was distributed to 133 Austrians of age 20-84, more rural than city residents, of Upper Austria and Salzburg. Thunderstorms were considered by them to be a medium risk. Women expressed more lightning fear. The general lightning knowledge and behavioral safety level is high in Austria, but some deficits remain. Three of four failed in a simple lightning distance calculation task. Folk beliefs were not dominant in this survey. Old people responded more cautious, but not folk belief-prone. Formal education and city/rural residence were no predictors for lightning knowledge and behavior.

Keywords: Lightning knowledge, folk beliefs, lightning myths, lightning safety, public education, Austria.

1. INTRODUCTION

Making sense of natural hazards such as atmospheric electricity constitutes an integral part of human culture. Thunder and lightning, powerful phenomena, were associated with higher beings and used as justification for religious belief systems for a long time. For homo sapiens, fire was an ambivalent element [1, 2], and lightning "fire from heaven". Worldwide, thunderstorm and lightning myths have been compiled by ethnology and religion research. For Europe, the main source is the classical dictionary of Baechtold-Staeubli [3]. International ethnographic material including lightning beliefs is online-searchable in the Human Relation Area Files (HRAF) [4].

In the social sciences, lightning is a subject of risk assessment research [5-7], where "hazard" means potential risk as a statistical value, and "risk" the probability of getting personally harmed. "Perceived risk" is the subjective estimation of being adversely affected. Whereas technical planning (risk engineering) makes use of mathematical formula, personal risk estimates can turn out to be irrational and erroneous. In general, common hazards (strokes, cancer) are underestimated by lay people, and infrequent hazards (tornados, lightning) overestimated. Adolescents without personal experience underestimate lightning fatality risk relative to tornado risk. Personal exposure to both risks results in more realistic estimations [8]. Public risk perception shows judgment errors – more vividly imagined ("available"), emotionally dramatic and media-present hazards are overvalued. Also, there is a false security ("overconfidence") that ones personal judgments are correct. This even goes for scientists and expert witnesses.

Medical lightning research is a large compendium [9, 10 etc.]. Cooper and Andrews explicitly addressed folk beliefs [11]. "Many 'modern myths' have hampered not only effective resuscitation of lightning victims, but also research in this area" [also 12, 13]. Clinical psychologists documented lightning accidents and their psychosocial aftereffects [14, 15]. Coorray *et al*. [16] mentioned subsequent Post-Traumatic Stress Disorder (PTSD): "It is usual that although physical injury can be marked, it is the psychological component of the injury that causes the most ongoing distress". Lightning is included as an item in the clinical Fear Survey Schedule [17], and "thunder and lightning phobia" is known as a psychopathological symptom [18, 19].

Researchers of the Americal Meteorological Society [20] as well as Holle *et al*. [21] found time-invariant risk patterns: An underreporting of lightning deaths and injuries; lightning as a single-victim accident etc. Therefore, personal responsibility has to be taken by the individual. The history of lightning conductors shows that science first has to come to terms with societal folk beliefs when widespread behavior change and general use and acceptance is intended. Contemporary folk beliefs or lay theories, i.e. non-expert cognitions [22], are enumerated in educational lightning material for lay persons [23-28]. Uman's "All about lightning" [28] is structured by frequently asked questions like "Does lightning 'never strike twice'?" With 1,330,000 Google hits (Feb 3, 2009) for the keyword "lightning myths", the possibility to obtain necessary information is high. However, people who hold folk beliefs will not question them as "lightning myths" but take them as facts.

Seen from the perspective of cognitive psychology, thunderstorms and lightning are no simple, comprehensible

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threats like alligators or speeding cars. Different from other natural hazards as floods or fire, lightning is a very short, random, rare event, never anticipated, with stochastic secondary events. To the general public it constitutes a complex, sometimes counter-intuitive and confusing danger: Buildings are safe, but not always. A car is safe, but a cabriolet is not. A lightning conductor gives safety, if you keep a safe distance from it.

Updating lightning safety issues, Cooper *et al*. [12] or Roeder [29] concentrate on "Go indoors", as there is no safe outdoor place (crouching is no longer suggested). People should quickly move to a shelter when the interval lightning-thunder is 30 seconds or less. Buildings are safe when windows, plumbing, or electrical installations are avoided.

For the optimum "diffusion of information" [30] in public education campaigns [31], the pre-intervention baseline and the post-intervention proportion of right or wrong public answers is an important factor and a measurement for mass communication results.

2. AUSTRIAN LIGHTNING KNOWLEDGE AND FOLK BELIEFS

2.1. Material and Method

Austria is a country with about eight million inhabitants situated mostly in the Alpine, mountainous territory of Central Europe. To get a fresh picture of Austrian lightning folk beliefs, a field study was organized. The project was planned with the Austrian Lightning Detection and Information System (OeVE-ALDIS) and the French Centre National de Recherche Scientifique (CNRS) [32] for the research network COST-P18 ("Physics of the lightning flash") of the European Science Foundation (ESF). Pre-test and main study were run by Environmental Psychology of Salzburg University *via* a seminar group in the 2008 summer term organized by the first author. He collected 44 lightning beliefs and myths from US, German and Austrian sources (Table **1**). A reduced number of them was used for a questionnaire.

The questionnaire comprises four sociodemo-graphic variables (gender, age, home town, education) and asks questions about several lightning-relevant topics: a) Seven items cover everyday weather information, quality of information, weather exposure/familiarity and risk assessment (including thunderstorms); b) 36 questions ask for an assessment of statements on 1. *lightning physics, meteorology and behavior* (23 items, some of them crucial for personal lightning protection), 2. *medical aspects* (4 items, 2 of them also folk beliefs) and 3. *folk beliefs* (11 items including the 2 medical ones); c) 8 final questions on personal lightning experience (3 items), self-rated folk belief-proneness, protection by a lightning conductor, knowledge of the Austrian lightning detection system ALDIS and of ball lightning.

Results of a pre-test were discussed at the 2008 COST-P18 meeting at Vienna [33]. The main survey was done with 133 Austrian residents in the urban and rural regions of the Federal provinces of Salzburg and Upper Austria. Rural environment was expected to mean living closer with the weather and being more exposed to lightning in the open. Sociodemographic and environmental effects were anticipated.

Table 1. 44 Lightning Myths/Folk Beliefs

Magic [3, first author]
Lightning is caused by supernatural powers.
Lightning is a warning, a premonition or a punishment.
Lightning can be used for fortune-telling or sorcery.
Animals, plants and substances can attract or ward off lightning.
Church-bells can ward off a thunderstorm/lightning.
You must not eat or laugh during thunderstorms.
Draught and open windows may attract lightning.
Weather [12, 13, 29]
In a thunderstorm, lightning only occurs with rain.
Lightning only occurs with thunderstorm clouds overhead.
Lightning cannot occur without thunder.
If you can see blue sky, lightning danger is minimal.
Location [11-13, 23, 28, 29]
Lightning never strikes twice at the same place.
Lightning always hits the highest point/strikes the tallest object.
Trees [3, 12, 29]
Hide under a tree to keep dry in thunderstorms.
Some tree species are hit by lightning more often.
Water [29, first author]
A ship/boat on the water is safe from lightning.
Swimmers are safe from lightning.
You can safely take a bath/shower during a thunderstorm.
Metal/EM effects [3, 12, 13, 29]
Metal on/off the body (e.g. wristwatch, jewelry) attracts lightning.
A(n active) cell phone/i-pod attracts lightning.
Medical items, injury [11-13, 29]
(M) Who is hit by lightning, is killed instantly.
(M) Who is hit by lightning, is severely burnt.
(M) Lightning victims can have "internal burns".
(M) Lightning victims are electrically charged and dangerous.
(M) Lightning victims are burned to a crisp, vaporized, or reduced to dust.
(M) Lightning can cause "suspended animation" without any brain damage.
(M) Lightning causes no cardiac damage if travelling over the right side of the body.
(M) Lightning victims have "entry" and "exit" points.
Technical protection/control, protection behavior [3, 11, 12, 23, 28, 29, first author]
A lightning conductor/rod can attract lightning and cause damage.
A roof antenna is as good as a lightning conductor/rod.
Lightning can be prevented.
First strikes from lightning can be predicted.
New high-tech types of lightning conductors/rods can control lightning.
A lot of energy may be technically generated from lightning.
The rubber tires on an automobile are what protects a person from lightning injury.
Wearing insulating rubber-soled shoes, raincoats etc. will protect a person.
You are safe from lightning inside a building.
Grounding a building makes it safe from lightning damage.
Go near a tall isolated object to be within the 45° cone of protection.
In a group you are safe from lightning.
Lie flat on the ground in a thunderstorm.
Running decreases the chances that lightning will strike you.
Other [12, first author]
All lightning flashes ignite a fire, quickly.
The majority of persons injured are golfers.

Sources [3, 11-13, 23, 28, 29, first author].

2.2. Results and Discussion

2.2.1. Survey Samples

The sample sociodemography is given in Table **2**, upper half. Austrian 2001 population data are used for a comparison [34]. To reduce selection bias, a randomized quota sample was taken.

To determine re-test reliability, a parallel seminar group asking people about everyday safety and risk preparedness included several lightning items in their questionnaire [35]. 100 adults made up a similar population (Table **2**).

Table 2. Sample Characteristics of the Austrian Survey Sample (●) and of an Independent Parallel Group (○)

●	133 adults
●	52.6% female and 47.4% male
●	Age range 20-84 years, mean age 42.6 years, age group 20<30 yrs 29% overrepresented (Austria 12.6%)
●	37.6% from a city/town, 62.4% from rural environment
●	78% education below high school level, 12% high school, 10% university (overrepresented; Austria 5.6%)
○	100 adults
○	63 Salzburg or Upper Austria, 37 Bavaria
○	55% female, 45% male
○	Mean age 47.3, range 21-85 years
○	26% academics

2.2.2. Subjective Risk

The subjective risk of lightning compared to other meteorological risks was quantitatively assessed. In the rank list (Table **3**), thunderstorm risk appears in the middle section. The Austrian top risk was "the heavy storm" – people had the last damaging storms Kyrill, Paula and Emma still in mind. The risk rank row for city respondents showed avalanches before flooding and fog before thunderstorm, the rural risk list had the same rank order as the average list of Table **3**.

Table 3. Weather Phenomena as a Subjective Risk (0-10), Rank List, Means

1.	Heavy storm	8.9
2.	Flooding	8.3
3.	Avalanches	7.7
4.	Ice on the ground	6.0
5.	Heat	5.5
6.	**Thunderstorm**	**4.7**
7.	Fog	4.5
8.	Heavy rain	3.8
9.	Snowfall	3.3
10.	Frost	3.0

Medium lightning risk was also found in the parallel group. In a ranking of 16 natural and manmade risks from 0 (lowest) to 10 (highest), lightning had a mean of 4.2 and the middle rank position number 8.

2.2.3. Weather Interest, Information

Asked for their interest in weather information, 67.7% expressed higher interest: 24.1 said they were always interested, 43.6% most of the time. 22.6% were interested from time to time, 9.0% less and 0.8% not at all. Higher weather interest was more frequent in a rural (72.3%) than in urban environment (60.0%). The Chi²-test difference city/rural was not significant (tested for $p<.05$, also in the following Chi²-tests).

Asked about their contact with the weather through the job or leisure activities, 24% found they were familiar and 76% they were not. 24% said they were always or mostly exposed to weather, 27% from time to time, 29% less and 20% not at all. The Chi²-test difference city/rural was not significant.

66% guessed to be well-informed about thunderstorms and lightning risks, 34% said they were not. The well-informed responders were more frequent in the city (73.5%) compared to the rural environment (62.2%). The Chi²-test difference was not significant.

A wish for better information on the subject was expressed by 40.6%; 59.4% said no. The wish for better information was more pronounced in the rural environment (48.2%) than in the city (28.0%). The test difference was significant ($Chi^2 = 5.276$, $p<.022$).

Anxiety in the open about thunder and lightning is shown in Fig. (**1**). Self-reported high fear values (very, mostly) are more frequent in rural (22.9%) than in urban environment (18.0%). Low fear (less, not at all) is more frequent in the city (66.0%) than in the country (55.4%). The Chi²-test differences were not significant.

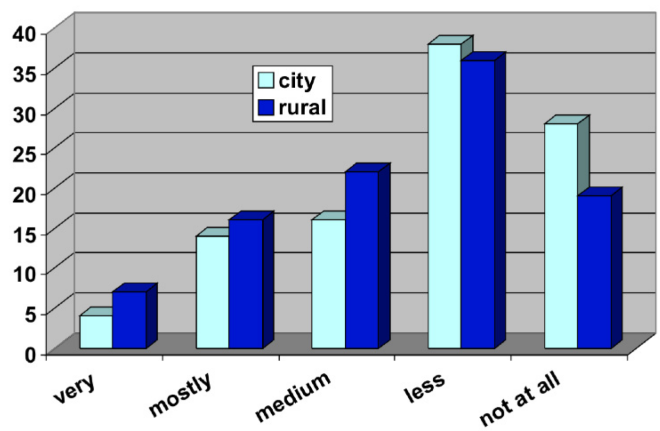

Fig. (1). Self-reported thunderstorm anxiety, city and rural population, percent.

2.2.4. Distance Calculation Task

A first test for behavior-relevant lightning information was the distance calculation question: *"8. When three seconds pass between visible lightning and its thunder, lightning has hit in a distance of ... kilometers."* The correct result is obtained by the multiplication of three seconds with the speed of sound, about 340 m/s, which gives a lightning distance of about 1 kilometer. Fig. (**2**) demonstrates that most lay estimates were wrong: Of the valid answers, 20.2% guessed the right distance, 1.7% had shorter estimates and 78.1% gave higher values.

The most frequent (and wrong) answer was 3 kilometers (54.6%). Wrong estimations ranged up to 100 kilometers, but values over 10 km made up only 11.8% of the answers. 10.5% of the respondents gave no estimate at all. Estimates from the city had a range of 1-30 km and a maximum of 3 km (65.9%). Rural estimates showed a higher standard deviation with a

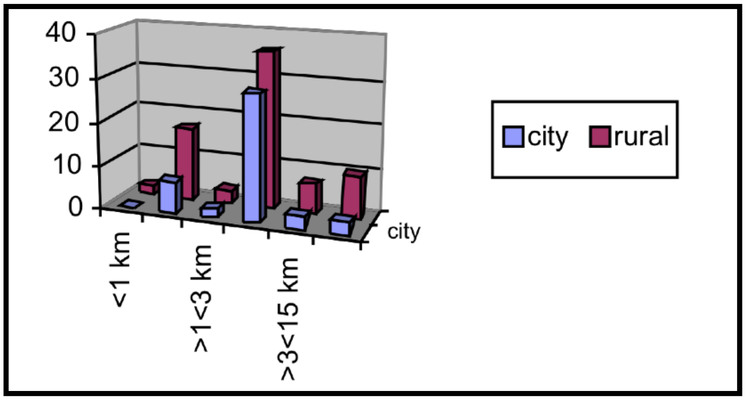

Fig. (2). Lightning distance calculation task, urban and rural estimates, percent.

range of 0-100 km and a maximum of 3 km (48.0%). The correct value was found more often in the country (22.7%) than in the city (15.9%). The Chi²-test difference city/rural was not significant.

The lay error seems to be "1 second = 1 kilometer distance", which gives three times higher distances and can be dangerous when used to guess safe lightning distances. As an educational result of this test, people should not be instructed to do the right computation but rather keep to the rule of leaving outdoor places at/under 30 seconds difference [12, 29].

2.2.5. Knowledge and Folk Beliefs

In the main body of the lightning questionnaire, 31 items probed thunderstorm, lightning and behavioral knowledge, 18 of them most relevant for survival. Physical knowledge, behavioral relevance and folk beliefs overlap in several issues, so it is not possible to have exclusive item categories. There are pure knowledge items without behavioral relevance and/or folk beliefs (e.g. There are positive and negative lightning flashes), there are knowledge, behavioral and folk belief items (e.g. Who is hit by lightning, is killed instantly) and likewise, also knowledge and behavioral items without folk belief (e.g. Lightning is only found beneath a thundercloud). In Table **4**, all 31 items are listed and divided into thematic groups.

Interpreting the findings of Table **4**, the most important facet is the number of correct answers when asking items of lightning survival value. 18 items ("main survival and medical") were the most survival-relevant. 13 of the 18 items were correctly answered by the majority of respondents. However, the percentage of correct answers shows different levels. If we regard items correctly answered by over 75% as "high skill", answers over 50% and under 75% as "medium skill" and under 50% as "low skill", we get the following picture:

High skill – *lightning not killing instantly, lightning not always igniting fire, group no lightning protection, lightning without rain, winter thunderstorms, unplugging electrical appliances.*

Medium skill – *lightning at same place, lightning and thundercloud, grid overvoltage, cardiac massage.*

Low skill – *lightning at highest point, tree hit rate, victims charged, bath safety, crouched position, 3 meters distance.*

Whereas it is reassuring that 6 items show high skill and 4 items medium skills, other behavioral items – getting into a crouched position and keeping 3 meters distance from objects – are in the low skill category of 6 items. The interpretation for this is controversial as "safe outdoor behavior" is no longer promoted by US experts, but in extreme danger without shelter, crouching and holding some distance from objects will be better than standing or tree contact. Lay people are uncertain whether lightning always hits the highest points and whether some tree species are hit more often. The two items are folk belief items in Austria, the latter integrated in traditional sayings and poems (e.g. "Stay away from oaks and find beech trees"). Even if real lightning damage differences exist for trees, this is no safe base for lightning protection education and people should rather keep away from trees instead of selecting "the right ones". The beech tree folklore was asked again as choice item 43 (Table **5**), this time with 88% of correct answers. The low skill result of the US folk belief "lightning victims are electrically charged and dangerous" [11, 12] at Austria was surprising, as this content is not discussed in public.

As for differences between city and rural residents on crucial items, significant test differences were found for "bath safety" (Chi² = 7.045, p<.008), and for "3 meters distance" (Chi² = 8.2, p<.004) with more correct rural answers than in the city for both items.

Other results from our survey are: People do not know the polarities of lightning, are not sure whether lightning causes cardiac death, do not know upward lightning, are overconfident about technical energy generation from lightning, are unsure about cellphone danger, refuse draught and church-bell folklore, know the difference between antenna and lightning conductor, refuse metal attraction, eating and lightning conductor folklore. Austrians make the right guess about the lightning maximum in the Federal province of Styria, but commit an eurocentric mistake by positioning the global lightning maximum (Africa) in their own continent.

The next questions asked for estimates of how many people are hit by cloud-ground (CG) lightning flashes in Austria every year and how many CG flashes per square km hit the "Austrian pre-alpine Basin" north of the mountains every year. The "person hit" figure varies from year to year, and not all cases are reported for official statistics, so 1 to 10 is a good guess. Fig. (**3**) shows that

Table 4. 31 Lightning Knowledge, Main Behavioral and/or Folk Belief Items, Thematic Groups, Percent

Main Suvival and Medical (M) Items	Yes	No	Don't Know
○ (M) Who is hit by lightning, is killed instantly.	15	**80**	5
○ Lightning never strikes twice at the same place.	20	**54**	26
○ Lightning is only found beneath a thundercloud.	18	**59**	23
○ All lightning flashes ignite a fire, quickly.	10	**79**	11
○ Lightning always hits the highest point.	32	**46**	22
○ Some tree species are hit by lightning more often.	31	24	**45**
○ On mountains, there are more lightning hits.	**47**	10	43
○ A ship on the water is safe from lightning.	6	**62**	32
○ (M) Lightning victims are electrically charged and dangerous.	13	40	**47**
○ In a group you are safe from lightning.	7	**82**	11
○ In a thunderstorm, lightning may be present without rain.	**94**	2	4
○ In a thunderstorm, overvoltage may occur in the grid.	**71**	3	26
○ There are no thunderstorms in winter.	9	**81**	10
○ You can safely take a bath/shower during a thunderstorm.	**36**	29	35
○ You should unplug electric appliances in severe thunderstorms.	**97**	1	2
○ In a crouched position you are more lightning-protected in the open.*	32	20	**48**
○ (M) Artificial respiration/cardiac massage can help lightning victims.	**68**	5	27
○ In a thunderstorm, keep 3 meters distance from trees.*	40	16	**44**
* Controversial – No safe places outdoors are promoted by US experts.			
Folk Beliefs About lightning	**Yes**	**No**	**Don't Know**
○ (M) Who is hit by lightning, is killed instantly.	15	**80**	5
○ Lightning never strikes twice at the same place.	20	**54**	26
○ All lightning flashes ignite a fire, quickly.	10	**79**	11
○ Lightning always hits the highest point.	32	**46**	22
○ Some tree species are hit by lightning more often.	31	24	**45**
○ (M) Lightning victims are electrically charged and dangerous.	13	40	**47**
○ Draught and open windows may attract lightning.	17	**70**	13
○ Church-bells can ward off a thunderstorm.	5	**91**	4
○ Metal (e.g. wristwatch, jewelry)attracts lightning.	33	27	**40**
○ You should not eat or laugh during thunderstorms.	1	**95**	4
○ A lightning conductor can attract lightning and cause damage.	16	**50**	34
General Lightning Knowledge	**Yes**	**No**	**Don't Know**
○ There is positive and negative lightning.	**22**	7	71
○ (M) Lightning kills mostly by cardiac death.	26	19	**55**
○ Upward lightning exists.	35	14	**51**
○ A lot of energy may be technically generated from lightning.	**78**	11	11
○ An active cell phone attracts lightning.	6	44	**48**
○ A roof antenna is as good as a lightning conductor.	7	**78**	15
○ Most lightning hits in Austria are in the Province of: 11 Vienna **62 Styria** 18 Vorarlberg			
○ The global lightning maximum was detected in: 17 Africa **64 Europe** 10 Sibiria			

Underlined values are the correct answers,.
bold values are response maxima.
Main survival and medical (M) items.

85.3% of the lay estimates are in the same area. The mean value is 3.16.

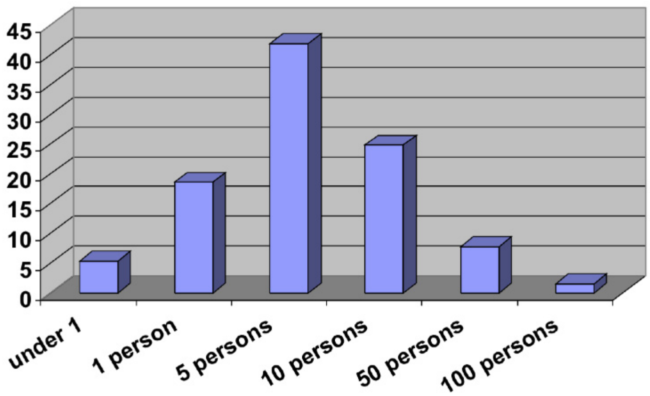

Fig. (3). Estimated persons hit by lightning per year in Austria, percent.

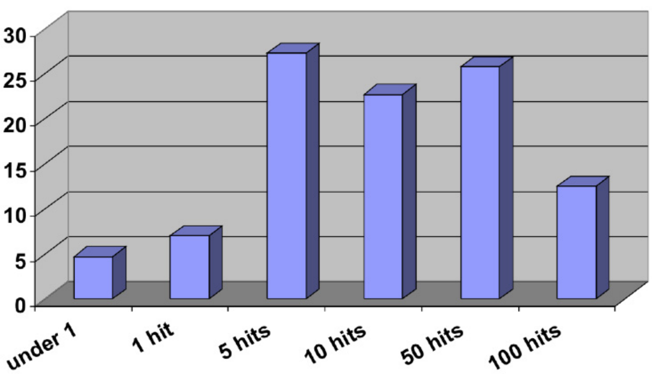

Fig. (4). Estimated CG flashes per square km north of Austrian Alps per year, percent.

For the subjective yearly number of CG flashes, Fig. (**4**) demonstrates an U-shaped maximum with 5 and 50 hits as peaks. The mean value of 3.95 lies near the correct value of 1-3 CG flashes per square km according to the 1992-2001 Austrian ALDIS statistics published at www.aldis.at. Again, the whole sample makes a good guess. Austrian ALDIS yearly CG flash rates (in a 10x10 km grid) vary between 0.5 near Vienna and in the southwestern Austrian Alps and up to 4.0 in central Austrian Alps' mountaintop areas.

2.2.6. Behavioral Choice Tasks

Choice tasks (Which spots are safe/unsafe in a thunderstorm?) tested safe versus dangerous action plans in the case of an imagined lightning exposure. The correct responses were put into a rank list in Table **5**. Places with over 90% correct responses can be called behaviorally well-know terrain – inside a building, near a high-tension power pylone, a body of water, in a car, an airplane, at the edge of a forest. Places under 75% correct responses show less knowledge – inside a forest, near a metal fence, on a field and especially in a hollow.

In the parallel sample (n = 100), the correct values for building, water, car, airplane and tree were repeated. Four less correct values showed again.

According to US lightning safety experts [11, 12, 29], moving to a safe indoor place is more important than outdoor risk reduction.

Table 5. 14 Lightning Behavioral Choice Items

○ **In a Thunderstorm, these Places are Relatively (Un)Safe:**	**n = 133** **Correct**	**n = 100** **% Correct**	***n = 133*** **%** ***Repetition***
- inside a building	**98**	**99**	***93***
- high-tension power pylone	**98**		
- standing/swimming in water	**94**	**94**	***99***
- in a car	**96**	**97**	***91***
- in an airplane	**92**	**95**	
- at a forest edge	**94**		
- under a single tree	89	**94**	
- under a beech tree	88		
- on a motorbike	87		
- on a hilltop	78	79	
- in a forest	68	74	*71*
- beneath a metal fence	70	81	
- on a field	66	57	
- in a hollow	58		

n = 133 group (*italics:item repetition*) and n = 100 parallel group (re-test reliability), percent.

2.2.7. Further Experience

A last group of questions listed in Table **6** dealt with lightning knowledge and experience. About every second respondent reported a lightning conductor at home. Only 13% are unsure. Contrary to a few folk belief items (beech tree folklore, lightning victims charged) still causing low-skill knowledge responses, 93% believed they were not superstitious about lightning. Kiessling [36], experienced in cognitive religion research, assumed that asking people in a university survey would result in lower self-reported folk beliefs than asking people in a different social context, e.g. in a religious survey [37]. We will test this in a 2009 field survey.

12% reported that lightning already hit their residential building, 62% said they watched a nearby CG flash and 96% had seen a lightning-damaged tree. Significant differences between city and rural areas were found for building hits – more frequent in the city, Chi² = 4.902, p<.027, and for nearby CG flashes – more frequent in the country, Chi² = 4.603, p.<.032. Damaged trees were seen everywhere.

ALDIS, the Austrian lightning detection and information network, was only known to 11% of the respondents. 80% had heard about ball lightning and 15% said they knew people seeing one. The ball lightning items showed no significant city/rural, gender or age differences. In Austria, the documented ball lightning report density is one case per 28,000 inhabitants [38].

2.2.8. Gender, Age, Education, Location Effects

With 51 weather- and lightning-related items, it makes no sense to test all against the sociodemographic variables (gender, age, formal education, city/rural environment). Instead, our inference statistics concentrated on lightning

Table 6. Eight Lightning Knowledge and Experience Items, Percent

	Yes	No	Don't Know
○ Does your residential building have a lightning conductor?	**54**	33	13
○ Are you superstitious about thunderstorms and lightning?	2	**93**	5
○ Has lightning ever hit your residential building?	12	**88**	--
○ Did you ever watch a nearby lightning flash to the ground?	**62**	38	--
○ Did you ever see a lightning-damaged tree?	**96**	4	--
○ Have you ever heard about ALDIS*?	11	**89**	--
○ Did you ever hear about ball lightning?	**80**	20	--
○ Did you or people you know ever observe ball lightning?	15	**85**	--

* ALDIS is the Austrian lightning detection and information system.

safety- and behavior-relevant aspects. As all but two items showed a non-normal distribution according to the Kolmogorov-Smirnov test, a non-parametric bivariate correlation (Kendall's tau τ) was used for significance testing.

Gender effects: Women indicated more thunderstorm fear (τ = .315 p<.000) or rather were more open to express their fear in the questionnaire. Women reported less lightning hits to buildings (τ = -.207 p<.018) and less nearby CG flashes (τ = -.191 p<.028) which may point to a more protective attitude with less observation.

Age effects: Old people expressed more thunderstorm fear (τ = -.174 p<.008), less weather exposure (τ = .256 p<.001) and kept better informed on weather (τ = -.259 p<.000). This is a more cautious and protective attitude. The folk belief of old people was not massive: Only four of eleven items showed a tendency - "lightning highest point" (τ = -.250 p<.002), "draught" (τ = -.316 p<.000), "church bells" (τ = -.156 p<.034) and "water unsafe" (τ = .236 p<.001, false tendency "water as safe place").

Education effects: There is no consistent effect of higher formal education on lightning knowledge and behavior. People with lower formal education kept better informed on weather (τ = .143 p<.049), had better knowledge on "lightning causing fire" (τ = .167 p<.043), false "charged lightning victims" (τ = -.160 p<.018) and "reanimation" (τ = .193 p<.037). They also knew better about "water as unsafe place" (τ = -.194 p<.013), "safe car" (τ = -.179 p<.022) and had seen more nearby CG flashes (τ = .195 p<.013). On the contrary, higher educated respondents guessed a lower (more correct) lightning distance (τ = -.164 p<.031), knew about "lightning not only under cloud" (τ = .195 p<.028), "unsafe group" (τ = .165 p<.048), about "safe building" (τ = .185 p<.018) and said they had more home lightning conductors (τ = -.212 p<.012).

As lightning protection is no general school subject in Austria, respondents with high formal education (except physicists and technicians) had no advantage when answering the questions. With high and medium skill about the majority of lightning security items (Table **4**), lightning education in Austria is not bad, but can be improved further.

City/rural environment effects: There was no systematic tendency of city or rural lightning knowledge and behavior deficits. Paradoxically, city residents felt more "exposed to weather" (τ = .204 p<.030) and estimated a higher thunderstorm risk (τ = .166 p<.028). City residents were less informed on "shower/bath safety" (τ = .285 p<.008, more false safety) and "3 meter object distance" (τ = -.331 p<.004, more false "no"). City residents said their houses had more lightning conductors (τ = .281 p<.003) and gave more correct answers than rurals for "water as unsafe place" (τ = .196 p<.024).

2.3. Conclusions

Physicists, engineers and physicians working in the lightning field are well-aware of its hazards to humans. A whole chapter of Rakov and Uman's handbook deals with human safety aspects [39]. To assess lay people's lightning theories, i.e. lay epistemology [40], and the role of the media as a means of transport for lightning information [41], social scientists should provide the empirical material.

To substantiate public myths and FAQ reported by international lightning experts [11-13, 23, 28, 29], the Austrian survey used a list of 51 items on lightning knowledge, risk awareness, folk beliefs, life-saving cognitions/behavior. Thunderstorms were considered a medium risk by the respondents. 68% indicated higher interest in daily weather information, but only 24% reported high weather contact/exposition. 66% felt well-informed about lightning risks, 41% desired better information. Women expressed more lightning fear. In a distance calculation task, 78% gave wrong estimates. On a list of lightning items, 13 of the 18 most relevant ones were correctly answered by the majority of respondents. The lightning knowledge level is high in Austria, but some deficits were detected: People assume lightning always hits the highest point (instead of a combination of highest and most isolated object), believe in different hit rates to certain trees (which suggests shelter) and do not fully realize side flash danger from nearby objects, even indoors. Folk beliefs were not dominant in this survey, although they may be more common in a different social context. Person hit risk and CG flashes per square kilometer show realistic results. The majority of 14 behavioral choice items (e.g. unsafe water) was answered correctly. Nearby CG flashes and lightning-damaged trees were experienced by most of the respondents. Old people express more caution and protection, but show no folk belief peak. Formal education and city versus rural residence were no consistent predictors for lightning knowledge and behavior.

To make the planned COST-P18 action of a European standardized lightning safety folder [42] socially efficient, lightning knowledge levels and folk beliefs should be routinely assessed by population samples in different EC countries and the key messages calibrated to the main knowledge deficits from the survey. The US state of the art of lightning protection – no certain lightning safety outdoors [29] – needs to be coordinated with European safety concepts *via* COST-P18. The Austrian Lightning Knowledge and Folk Beliefs Questionnaire or parts thereof can be used to test pre- and post-intervention knowledge in national or regional public relation campaigns on lightning protection. As in other areas of environmental psychology, empirical evaluations are helpful to monitor and uphold quality standards in public education in accordance with up-to-date research results of protection experts.

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