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Title: **Development and validation of a 'MyLyt' wearable light tracking device**

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Running head: Development and validation of light tracker

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Abstract

Purpose: We have developed a clip-on light tracker (MyLyt) for estimating light exposure in real-time. This study aimed to validate and investigate the feasibility of using MyLyt in children and adults.

Method: The study was conducted in two phases. Phase 1 involved validation against a factory-calibrated digital lux meter in three separate conditions- controlled environmental setup, outdoors, and indoors where intra-test (two measurements by same tracker), inter-test (measurements among trackers) and inter-device (MyLyt tracker and lux meter) validations were conducted. Phase 2 involved a feasibility study where MyLyt was used in a real world setting by 21 adults and 8 children. Participants were asked to log their real-time movements in an 'activity diary' which were correlated with the lux levels measured by the tracker.

Results: A strong positive correlation and non-significant difference in the recorded mean illuminance levels were observed during intra-test (Inter class correlation: 1.00, P=0.99 respectively), inter-test (0.91-1.00, P>0.15) and inter-device (0.91-1.00, P>0.56) validation, in all the three testing conditions (P>0.49), except indoor location. While the lux levels measured by MyLyt was significantly higher than that of lux meter (P<0.01) in the indoor locations, the differences were minimal and clinically insignificant. Bland-Altman plot showed a minimal mean difference [95% limits of agreement] between MyLyt tracker and lux meter in all the three conditions (controlled environmental setup: 641 [-949, 2,230], outdoor: 74 [-2,772, 2,920], and indoor: -35 [-151,80] lux). Phase 2 validation showed an expected illuminance level against their corresponding location with high sensitivity (97.8%) and specificity (99%) to accurately differentiate between outdoor and indoor locations.

Conclusion: The MyLyt tracker showed good repeatability, strong correlation and comparable values amongst each other and with lux meter in all the three tested conditions, making it suitable for tracking light exposure patterns for both research and clinical purposes.

Key Points

1. MyLyt tracker shows good agreement with lux meter in recording light levels in both outdoor and indoor conditions.

2. The features of MyLyt trackers, such as unique mounting position, better safety, durability and cost-effectiveness makes it suitable to be used extensively in research and clinical purposes.

3. MyLyt tracker can help in altering behavioral profile of children by motivating them to spent extra time at outdoors and has high potential for its application in myopia.

Introduction

There is no deny that use of technology is increasing in modern health sectors.[1, 2] From the use of bulky instruments in the earlier days, health industries now-a-days are more inclined towards developing portable wearable devices.[3, 4] Currently available such commercial trackers can record several vital functions of body, such as heart beat rate, oxygen saturation level (SpO2), breathing rate, body temperature, calorie burnt, sleep pattern, physical activity etc.[5-7] Similar kind of trackers are also developed and used in myopia research to understand several parameters related to light exposure level in children and adults.[8-11]

The technique of recording time spent outdoors transformed with the advancement in technology, from a conventional method of tracking Geographical Positioning System (GPS), to administration of questionnaire, and more recently using a wearable light tracking devices.[12] The high risk of recall bias limits the use of questionnaires and diaries, and as an alternative, light trackers were introduced to objectively quantify the properties of time spent at outdoors.[12] These trackers were developed in the form of wrist watch, arm band, pendants, or attachable clips to the spectacles. The use of commercially available light trackers such as Actiwatch (Philips Healthcare, The Netherlands), HOBO pendant (Onset, USA), or Clouclip (Glasson Technology, China) revealed that myopic children are exposed to relatively lower illuminance level and for shorter duration compared to non-myopic children.[13-16] Recently, the illuminance recordings from wearable trackers are also being synchronised with a companion smartphone application to encourage children to increase time outdoors.[17]

Unfortunately, commercially available current trackers are expensive which limits extensive use of these trackers in both myopia research and clinics, increasing the dependency on subjective responses of children or parents for critical information related to light exposure. This warrants a need of cost-effective trackers for its easy dissemination to children for quantifying and increasing their time in outdoors, and in research to further explore the interactive role of light and myopia. With the combined effort of myopia researchers and engineers, we have developed a device that can track the light exposure level in a real time. This study aims to clinically validate and study the feasibility of newly developed wearable light tracker.

Methods

The light tracker, also named as 'MyLyt', was developed at L V Prasad Eye Institute (LVPEI) in a collaboration between the Myopia Research Lab and Center for Technology Innovation. It records ambient light levels measured as a function of illuminance (in lux) against real time (date and time). The validation of MyLyt tracker was conducted in two phases; phase 1 involved validating the trackers against a factory calibrated digital lux meter (Sinometer LX1330B, China, https://m.made-in-china.com/product/High-Quality-Digital-Lux-Meter-Lx1330b-621291942.html) with output range of 0 to 200,000 lux. Phase 2 involved dispensing the tracker to 15 adult and 8 children volunteers to check its feasibility in the real-world setting. Relevant ethics approvals were obtained from the LVPEI and City, University of London's Institutional Review Board to conduct study on human participants (IEC number- LEC 10-19-354, and ETH2021-0998 respectively) and the procedures were performed in accordance with the tenets of the Declaration of Helsinki.

Construction of light tracker

The internal hardware design of the tracker consists of several parts, as shown in Figure 1A. The ambient light sensor (TSL25911) is a complementary metal oxide semiconductor (CMOS) that converts light to a digital signal. This digital output acts as an input to the microprocessor where illuminance (ambient light level) in lux is derived to approximate the human eye response. An in-built real-time clock (RTC) provides an actual time stamp and date for data logging. The lux value along with time and date is saved on board flash memory. This is important to understand the amount of time spent by users in different lighting conditions. The device is supplied with a low power Lithium polymer (Li-Po) battery (450 mAh, 3.7 Volts) with a battery charging and protection circuit.

The external case of the tracker is made up of aluminium metal with a stainless-steel anchoring hook (Figure 1B). The front surface of the tracker case has two apertures, each sealed with a transparent optical window made from polymethyl methacrylate (PMMA), to allow visibility of LED color and to transmit ambient light to fall on the lux sensor. The on board bi-colour LED indicates active data sampling (green color) and low battery status (red color). The detailed technical specifications of MyLyt tracker is provided in Table 1.

Table 1. Technical specification of MyLyt tracker

SN	Parameters	Values
1	Dimension	47x37x16.4 mm (length x breadth x height)
2	Weight	50 grams
3	Range of electromagnetic spectrum measured	400 to 850 nm
4	Range of Lux value	0 to 88,000 lux
5	Peak sensitivity	Visible spectrum- 600-655 nm
6	Area of sensor aperture	85.96 mm^2
7	Sampling time	Adjustable
8	Types of measurable data	Illuminance, Date and Time (In real time)
9	Data saving and extraction	Manual, uses flash memory of 6 Giga Byte
10	Battery power	450 mAh at 3.7 Volt
11	Battery life	7 days at sampling rate of 60 sec/data
12	Charging method	Wired (USB charging)
13	LED indicator	Green- data sampling, Red- low battery level
14	Safety consideration	Closed completely, tightly coupled metal enclosure, and internal battery protection

Validation of light tracker

Phase 1 validation

The phase 1 validation was conducted in two types of environments- a) controlled environmental setup, and b) natural outdoor and indoor settings.

a) Controlled environmental setup

Validation under a controlled environmental setup was conducted using a custom-designed standard intensity calibration apparatus consisting of an artificial closed chamber, where lux level can be adjusted between 0-55,000 lux by regulating the LED light source (white light) through an externally connected rheostat (Figure 2). The setup is constructed to accommodate a maximum of four static trackers simultaneously, placed in a horizontal plane with respect to the apparatus, and illuminating the surface diffusely from the top. To avoid internal reflections within the closed chamber, a black acrylic sheet was pasted on all the internal surfaces of chamber.

Initially, a lux meter was placed inside the chamber and measurement was recorded. Keeping the illuminance level constant, four trackers were either simultaneously placed or one after another inside the chamber, and measurements were recorded continuously for two minutes at a sampling rate of 5 seconds/data. The illuminance level was gradually increased after each set of measurement until it reached the maximum limit of setup.

b) Natural outdoor and indoor setting

The same four MyLyt trackers and a lux meter used in the controlled environmental setup were used for validation in natural outdoor and indoor settings. The indoor setting was a closed room (Length x Width x Height: 3 x 2 x 3.2 meters) containing one fixed Light Emitting Diode tube (LED, 40-Watt, Cool white) and six smart LED bulbs (12-Watt, Cool white, Wipro Enterprises Ltd., Shenzhen, China) which were manipulated to change intensity of the ambient light. In the outdoor location, illuminance level was captured facing the sensors in four cardinals (East, West, North and South) and upward directions (facing sky) in open terrace and under the shade. In both the indoor and outdoor locations, trackers and lux meter sensors were always kept static, facing the same direction. The MyLyt trackers were set to record illuminance level at a sampling rate of 5 seconds/data recording.

Phase 2 validation

Phase 2 validation was conducted by dispensing trackers to 21 adults (mean±SD age- 28±3.4 years) and 8 children (9.5±2.8 years) with clear verbal instructions on appropriate handling of the device. Instructions were mainly about maintaining safety and accuracy measures, such as- i) do not change the location of tracker placement, ii) do not dip tracker under water, and iii) keep the sensor always uncovered. The tracker was clipped on the participant's cloth, just below the neck, in an upper thoracic region, as shown in Figure 1C. Unlike in phase 1 validation, data was captured for a period of 5 hours with a sampling rate of 2 minutes/data recording in order to minimize amount of data that MyLyt generates in a period of 5 hours. Participants were also asked to log their real time movements in different outdoor and indoor locations in an 'activity diary'. The information from the activity dairy on subjectively reported environment/ location was correlated with lux level measured by the tracker.

Statistical analysis

IBM SPSS statistics 20 (SPSS, Inc, Chicago, IL) and Microsoft Excel 2016 (Microsoft Corporation, USA) were used to analyse and plot the graphs respectively. For phase 1 validation, agreement between two readings recorded by the same tracker (intra-test validation), agreement among four trackers (inter-test validation), and agreement between MyLyt tracker (averaged value of four MyLyt trackers) and lux meter (inter-device validation) were conducted. Independent samples t-test, one-way ANOVA (for inter-test validation), inter-class correlation (ICC), Cronbach's alpha and Bland-Altman (BA) plot were used for establishing statistical validation. During data collection in the closed indoor room, there were times when all the sources of light were off, leading the tracker to record 'zero' values, however, for the purpose of analysis, we did not consider "zeros". P value <0.05 was considered as statistically significant.

For phase 2 validation, lux values obtained from the trackers were harmonized against the corresponding locations (outdoor/indoor) obtained from activity diary of the participants. If the illuminance level was ≥1,000 lux, the location was considered as outdoors, whereas indoor location was defined when illuminance level was <1,000 lux. The threshold illuminance level (1,000 lux) to differentiate outdoor location from indoor is based on the already published literature.[14, 16, 18, 19] Qualitatively, a) outdoor location is defined as an open space from all the sides with no obstruction for sunlight to directly fall on the participant's body surface; and b) indoor location is defined as a space enclosed within four walls and roof where artificial light is the main source of light. The sensitivity and specificity of MyLyt tracker to differentiate between outdoor and indoor location was also calculated based on the cut off value of 1,000 lux.

Result

Phase 1 validation

a) Controlled environmental setup

The validation of MyLyt trackers in a controlled environmental setup was conducted under illuminance ranging from 0-30,000 lux (as measured by lux meter). The absolute illuminance level recorded by all the four trackers and a lux meter, and the mean differences between them are shown in Figure 3 and Table 2, respectively. The intra-test validation exhibited an insignificant difference (3.4±44.8 lux, P=0.99) between two sets of readings recorded by same tracker with a very strong correlation (ICC= 1.00, Cronbach's alpha= 1.00). Likewise, inter-test validation and inter-device validation also showed an insignificant difference in lux values and strong positive correlation (ICC= 0.99, P<0.01) amongst all the four trackers (P=0.99, One-way ANOVA; Cronbach's alpha= 1.00), and between the tracker (averaged value of four individual MyLyt trackers) and lux meter (Cronbach's alpha= 0.99), respectively. Bland-Altman analysis also indicated good agreement between lux meter and MyLyt tracker with the overall mean difference [95% Limit of agreement] of 641 [-949, 2230] lux.

b) Natural outdoor and indoor setting

The illuminance level under which validation in the outdoor and indoor setting was conducted ranged between 1,660-56,520 and 4-810 lux, respectively. Similar to controlled environmental setup, intra-test validation showed a non-significant difference and strong positive correlation between two sets of readings recorded by same tracker in both the outdoor (4.58±123.6 lux, P=0.99, ICC=1.00, Cronbach's alpha= 1.00) and indoor locations (1.88±4.71 lux, P=0.88, ICC=0.99, Cronbach's alpha= 0.99). Inter-test validation amongst four trackers also showed non-significant difference in mean lux levels and strong positive correlations in both outdoor (P= 0.91, One-way ANOVA; Cronbach's alpha= 0.99) and indoor locations (P= 0.52, One-way ANOVA; Cronbach's alpha= 0.99). While a strong positive correlation was found during inter-device validation between tracker and lux meter in both the outdoor (Cronbach's alpha= 0.99, P<0.01) and indoor locations (Cronbach's alpha= 0.95, P<0.01), a non-significant difference in the lux level was present only in the outdoor locations (P>0.72), as shown in Table 2. The absolute illuminance level recorded by all the four trackers and a lux meter, and the Bland-Altman analysis (as shown in Figure 4) indicated a good agreement between the tracker and lux meter with a mean difference [95% Limit of agreement] of 74 [-2,772, 2,920] lux in outdoor and -35 [-151, 80] lux in indoor conditions.

A subset analysis in the outdoor location showed small mean difference and standard deviations at a lux level ≤10,000 lux (179±143 lux) compared to lux level >10,000 lux (1,583±2,180 lux), indicating although the overall difference in lux level recorded by MyLyt and lux meter is high, the differences were lesser when ambient outdoor illumination is <10,000 lux.

Table 2. Mean difference in illuminance levels, P-value and inter-class correlation among four trackers, and between averaged reading of four individual MyLyt trackers and lux meter.

	Tracker 1	Tracker 2	Tracker 3	Tracker 4	Lux meter	Averaged reading of 4 MyLyt trackers
Controlled Environmental Setup						
Tracker 1		1.00	1.00	1.00	1.00	
Tracker 2	-117±378, 0.79		1.00	1.00	1.00	
Tracker 3	-71±181, 0.88	47±214, 0.91		1.00	1.00	
Tracker 4	-90±222, 0.84	27±169, 0.95	-19±66, 0.96		1.00	
Lux meter	159±384, 0.74	276±750, 0.56	230±558, 0.63	926±603, 0.60		229±829, 0.63; ICC= 0.99
Outdoor						
Tracker 1		0.99	0.99	0.99	0.99	
Tracker 2	1,282±3,000, 0.49		0.99	0.99	0.99	
Tracker 3	1,082±3,468, 0.55	-200±3,914, 0.91		0.99	0.99	
Tracker 4	810±1,986, 0.65	-472±1,234, 0.80	-271±3,590, 0.88		0.99	
Lux meter	641±2,455, 0.72	-640±2,316, 0.74	-440±2,461, 0.81	-191±1,921, 0.92		-151±1,375, 0.93; ICC= 0.99
Indoor						
Tracker 1		0.98	0.98	0.97	0.90	
Tracker 2	4±24, 0.69		0.98	0.98	0.90	
Tracker 3	-9±24, 0.38	-5±12, 0.63		0.98	0.91	
Tracker 4	-14±37, 0.15	-10±25, 0.30	-5±22, 0.58		0.94	
Lux meter	-32±65, <0.01	-28±64, <0.01	-23±58, <0.01	-17±44, <0.01		-25±66, <0.01; ICC= 0.91

The results within blue shade represents mean difference ± SD with P-value, and within green shade represents inter-class correlation coefficient (ICC).

Phase 2 validation

The light exposure pattern of one of the participant plotted against their corresponding locations recorded in the activity diary is shown in Figure 5, and the activity diary is provided as a supplementary file S1. Out of 29 participants (21 adults and 8 children), 14 participants reported to be in outdoor location, and all the 29 participants reported to be in indoor locations at least once within the five hours of study time frame. The sensitivity and specificity of the trackers to accurately differentiate between outdoor and indoor locations, based on the cut-off value of 1,000 lux was 97.8% and 99% respectively.

Discussion

This study aimed to clinically validate a new light tracker (MyLyt) against a gold standard lux meter. The MyLyt tracker showed a good correlation and comparable output during intra-test, inter-test and inter-device validation process, in all the three testing conditions (controlled environmental setup, outdoor locations and indoor locations). The trackers were also found to record expected illuminance level matching with the participants' self-reported locations recorded in their activity diary, and the trackers were able to accurately differentiate between outdoor and indoor locations with high sensitivity and specificity.

We observed that the spread of individual mean difference data points corresponding to lower lux levels were closer to the line of bias compared to the data points corresponding to higher lux level (Figure 3B, 4B and 4D), in all the three tested conditions. This indicates that the differences in lux levels recorded by MyLyt trackers and lux meter increased with the increase in brightness of an ambient light. However, the absolute and percentage differences were minimal: 9±24 lux for mean illuminance level ≤1,000 lux (mean of tracker and lux meter reading) accounting for a 5% deviation, 179±143 lux for 1,000 to ≤10,000 lux (3.2% deviation) and, 1,583±2,180 lux for >10,000 lux (6% deviation). Despite these differences, clinical application of MyLyt tracker may not be affected, given that such deviations are expected to cause negligible impact on the overall performance of light tracker. The largest bias in the outdoor location was 4,037 lux for the corresponding mean illuminance level of 20,711 lux (Figure 4B), accounting for 19% differences, and even if MyLyt deviates by 19%, lux level will still enable it to be classified as 'outdoors'. In addition, the standard deviation is much lower when ambient illumination level was <1,000 lux vs <10,000 lux vs >10,000 lux (24 vs 143 vs 2,180 lux respectively), indicating lesser variation and higher accuracy in detecting indoor and outdoor condition, when 1,000 lux is considered as threshold. Howell et al.[20] validated Clouclip and Actiwatch 2 light trackers for estimating illuminance levels by comparing against gold standard photometer in a real world conditions consisting of both indoor and outdoor locations. Within the illuminance range of 0-3,700 lux for Cloculip and 0-6,850 lux for Actiwatch 2, the overall illuminance level measured by these devices was underestimated by 431 lux and 80 lux respectively, compared to the photometer. In contrast, the combined data of outdoor and indoor locations from MyLyt trackers for the same range of ambient illumination showed an overestimation by 127 and 50 lux respectively. The intra-test, inter-test and inter-device validity showed negligible mean difference and SD, indicating that MyLyt trackers have high repeatability, can be used interchangebely with each other, and can be used as a personalised wearable lux meter, respectively.

Phase 2 validation process showed the lux level recorded by current trackers were matching with the self-reported corresponding locations as indicated in the activity diary. For example, in Figure 5, participant recorded his/her presence in an outdoor location in the activity diary, and the corresponding recorded illuminance level ranged between 732-51,429 lux, and in the indoor location ranged between 0-636 lux. We also enquired about the feasibility of using trackers with all the participants (not mentioned in the result section), and none of them reported any difficulty in mounting or using trackers. Throughout phase 2, MyLyt tracker was indeed successful in differentiating indoor from outdoor locations (based on the cut off of 1,000 lux as considered in other studies)[14, 16, 18, 19] exhibiting high sensitivity (97.8%) and specificity (99%), which was comparable with Actiwatch 2 (sensitivity- 99.7% and specificity- 100%) and Clouclip (sensitivity- 91.7% and specificity- 100%).[20] The sensitivity and specificity of MyLyt is slightly lower when compared to Actiwtch 2, which could be attributed to the inclusion of physically active children in this study who can have high chances of mis-documenting outdoor and indoor location in the self-reported activity diary compared to static mannequin head used by previous study.

Currently available commercial trackers (for example Clouclip and Actiwatch) usually have an externally exposed charging port, bluetooth or Wi-Fi for data transfer facility, and require a separate smartphone application to connect to device or attain data remotely. They are also often equipped with additional sensors such as sleep tracker, activity tracker, heart rate tracker etc, which inevitably makes them more expensive. Considering that current trackers are meant to be used by children on a large scale, attention was given to make it durable, secure and cost-effective. Thus, we used an aluminium case with no external opening to enclose all the components such as battery and flash memory within it. This made the MyLyt trackers durable and secure against chances of losing the flash memory and resistant to any physical or water damage. Additionally, the current tracker was meant to measure only light exposure level and was devoid of other sensors such as sleep, activity or heart trackers, which makes MyLyt cost-effective compared to currently available commercial trackers. The future version of MyLyt tracker will be able to connect with a smartphone to accommodate smooth data transfer.

There are few limitations of current tracker, of which, i) one is its mounting position, which is just below the neck in the upper thoracic region. The ideal way to track the light exposure profile of an individual is by quantifying the retinal illuminance, but, in view of currently available technologies, mounting a tracker adjacent to the eye would be a preferred approach. However, the current mounting position was chosen as these trackers are also meant to be dispensed to emmetropic participants who do not use or hesitates to use spectacles. In addition, a clip-on tracker like MyLyt is likely to have an advantage over a wrist mounted tracker, as the later could hamper the data collection due to obstruction of sensor with full sleeves or any other physical object. ii) The upper range of lux value that MyLyt can measure is 88,000 lux. Depending upon the location, the illuminance level at outdoors might exceed 100,000 lux, and if children are exposed to such a high illuminance level, MyLyt records illuminance value of 88,000 lux. However, it should be noted that in such high illuminance conditions which are indicative of exposure levels representing outdoor environment, 88,000 lux is sufficient enough to indicate that the child was exposed to very high level of ambient light. iii) MyLyt is a prototype device and the size and weight are bulky compared to the commercially available similar devices. In the subsequent versions, trackers will be designed to make it compact and light weight. iv) The current trackers were tested under white light in all the three conditions where the source of light was either LED's (tube/bulb) or sunlight. Nevertheless, MyLyt tracker were also sensitive to pick light emitted by digital screens such as desktop screen (experiment not mentioned in the manuscript).

The role of different monochromatic wavelength of light in altering the ocular growth is evolving rapidly, but majority of the trackers only measures illuminance level. Actiwatch spectrum (Philips, USA), a tracker mounted as a wrist-watch, is capable of recording irradiance value of monochromatic wavelength of light ranging from 400-700 nm, along with illuminance level.[21] However, the device is expensive to be used in a large clinical trial, embraces the limitation of mounting trackers at a wrist level, and has significant inter-watch differences.[22] Thus, the future versions of light trackers should incorporate all of these features to holistically track and quantify the light-environment based behavioral profile of the user.

There is a growing concern on the rising prevalence and incidence of juvenile myopia, and time spent outdoors is the safest and cost-effective strategy to tackle this.[23] Several public health initiatives related to time outdoors have been described in the literature,[24-26] where the use of light tracker can play a crucial role in better understanding the pattern of light exposure, motivate children to be outdoors, and design future light-based therapies. The role of MyLyt in tracking light based behavioral profile of children in myopia research needs further exploration. In conclusion, the newly developed MyLyt tracker shows a good repeatability, good correlation and limited variation in data recording amongst trackers and in comparison to a digital lux meter in diverse environment. Furthermore, MyLyt tracker is able to accurately differentiate between outdoor and indoor locations. Its features related to accuracy, durability, safety and cost-effective nature makes it suitable for tracking light exposure patterns for both research and clinical purposes.

Competing interest- None

Contributors- PKV conceptualized product development and funding acquisition; **PKV, RD, JRR and HSC** designed methodology; **JRR and HSC** developed product and conducted initial validation in lab; **RD** performed data collection for clinical validation, analysed data, prepared first draft of manuscript and worked on subsequent revisions; **PKV, HSC, JGL, BH and RS** supervised and reviewed the manuscript. All the authors have approved the final manuscript.

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Figure legends

Figure 1. A) Overall circuit diagram of the light tracker showing different parts embedded with each other. B) Front and rear surface of light tracker. C) The mounting position of MyLyt tracker in human participants

Figure 2. Panel A represents closed chamber environmental setup connected to a rheostat that controls amount of illumination inside the chamber. Panel B represents a tracker placed inside the chamber

Figure 3. Illuminance level recorded by four MyLyt light trackers and a lux meter at high lux level ≥1,000 lux (Panel A) and low lux level of <1,000 lux (Panel B) in a controlled environmental setup. X-axis represents different illuminance level under which test was conducted. After each set of measurements, the trackers were placed in an upside-down position such that sensors were deprived of light, and recordings indicated 'zero', defined as 'blackout position'. C) Bland-Altman plot showing agreement between MyLyt tracker (average of four trackers) and lux meter in a controlled environmental setup. The continuous line represents mean difference between MyLyt tracker and lux meter, and dotted line represents upper and lower 95% limits of agreement calculated as mean ± (1.96*standard deviation)

Figure 4. Illuminance level recorded by four MyLyt trackers and a lux meter in outdoor (Panel A) and indoor conditions (Panel C). Panel B and D represent Bland-Altman plots showing agreement between MyLyt tracker and lux meter in outdoor and indoor conditions, respectively. The continuous line represents mean difference between tracker and lux meter, and dotted lines represent upper and lower range of 95% limit of agreement calculated as mean±(1.96*standard deviation)

Figure 5. Light exposure pattern of one of the participants measured as lux in different outdoor and indoor locations. X-axis represents the self-reported locations of participants obtained from activity diary.

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