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Assessing the Relationship Between Implicit and Explicit Evaluations of Fruit and Vegetable Consumption by Cancer Survivors

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Abstract

Background Currently, little is known about the implicit evaluations that cancer survivors have for health behaviors, such as eating fruits and vegetables. Understanding both the implicit and explicit evaluations of fruit and vegetable consumption among cancer survivors may aid future interventions for changing motivations and intentions in this higher risk population.

Methods A cross-sectional study at a university cancer center assessed explicit and implicit evaluations of fruit and vegetable consumption among 122 cancer survivors. The explicit evaluations regarding fruit and vegetable consumption were self-report data. To obtain implicit evaluations, participants completed an implicit evaluation task, the Affect Misattribution Paradigm. Moderating variables of time since first cancer treatment and if participants had a prior cancer occurrence were also self-reported.

Results Simple correlations found no significant association between the implicit and explicit evaluations of fruit and vegetable consumption. Moderation regression analyses showed that the implicit and explicit evaluations became negatively associated as time since first treatment increased and when participants had a prior cancer occurrence.

Conclusion The results support the view that implicit and explicit measures of fruit and vegetable consumption diverge for cancer survivors, consistent to implicit and explicit evaluations in other domains and samples. Further, the association between these evaluations differed depending on time since first treatment and if they have been treated for a prior cancer occurrence. By knowing more about implicit and explicit positive evaluations, and their moderators, it may be possible for interventionists to alter cancer survivors' motivation and intention to eat fruits and vegetables.

Keywords Cancer survivors · Cognitive beliefs · Eating behavior · Implicit · Oncology · Nutrition

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Introduction

Cancer survivors face elevated risk for cancer recurrence, the onset of other forms of cancer, and other chronic health conditions [1–3]. Importantly, healthy eating can reduce mortality and morbidity risks for cancer survivors [4]. For example, breast cancer recurrence is lower for women who eat the recommended amounts of fruits and vegetables [5]. Diet quality in cancer survivors, however, is lower than in the general population [6]. One viable strategy for increasing the healthy eating motivation and intentions of cancer survivors (i.e., variables with a causal influence on behavior) is by changing evaluations of eating healthy foods, such as fruits and vegetables [7, 8]. Many theories suggest that positive evaluations of fruits and vegetables increase fruit/vegetable consumption motivation and intentions [7]. Importantly, recent research reveals that evaluations exist at both an explicit level (e.g., consciously believing eating fruit is beneficial) as well as an implicit level [9]. Implicit evaluations refer to automatically

accessible reactions that result from existing mental associations with an overall conceptual category (e.g., fruit consumption and exercise [10, 11]). Thus, a cancer survivor may evaluate vegetables positively at an explicit, conscious level, while still holding a negative evaluation of vegetables at an implicit, nonconscious level. Little is known about the implicit evaluations that cancer survivors have of health behaviors, such as fruit/vegetable consumption.

Interventions to change evaluations of a healthy diet have traditionally targeted explicit evaluations [12]. There is emerging evidence, however, that interventions can directly target implicit evaluations [9]. Implicit and explicit evaluations are sometimes related while other times unrelated [13, 14], and further, they may alter motivations and intentions independently, additively, or even interactively [15]. Given their distinctiveness, interventionists may need to focus on changing (1) explicit evaluations, (2) implicit evaluations, and (3) both implicit and explicit evaluations simultaneously. What type of evaluation is targeted would alter intervention content and determine intervention attributes, such as intervention length.

To elucidate when interventions should target explicit evaluations, implicit evaluations, or both, it is valuable to understand the factors that predict when these evaluations align and diverge. That is, if a variable predicts when scores on implicit and explicit measures are more highly correlated, it provides information on the contexts when one or both evaluations need to be targeted separately by interventions. Here, we examined the correlation between implicit and explicit evaluations of fruit/vegetable consumption of cancer survivors.

In addition, we tested how the experience an individual has with being a cancer survivor moderates the associations between implicit and explicit evaluations of fruits/vegetable consumption. This question was motivated by three reasons. First, existing research suggests that discrete and salient recent (as opposed to distal) experiences (e.g., meaningful or memorable life events) lead to greater correspondence between implicit and explicit evaluations. For example, Castelli et al. [16] found that recent experiences (e.g., attending religious services in the past few days) influenced both implicit and explicit evaluations, whereas distal experiences (e.g., attending religious services many years ago) less consistently influenced both evaluations. In line with this evidence, we suggest that a cancer diagnosis can be considered a salient, discrete, and meaningful personal event and that when one is temporally closer to the cancer diagnosis, implicit and explicit evaluations related to cancer experiences should be more similar. Second, attitude domains that are important to an individual and are thought about more frequently tend to have greater correspondence in implicit and explicit evaluations [14]. Based on data showing that those with a more recent cancer diagnosis report higher risk perceptions and more frequent thoughts about their cancer [17], we surmised that thoughts related to one's diet would be more pressing and more frequently accessed early on in survivorship—thus leading to greater implicit and explicit correspondence. Third, the amount of experience as a cancer survivor is a valuable moderator to test because, if it does moderate, it can be easily accessed by practitioners and interventionists, thus allowing for future application. In this study, we operationalized amount of experience as a cancer survivor with two variables: time since initial cancer treatment, which here varied from 4 months to more than 20 years, and whether the participant had been treated for a prior cancer occurrence, here, measured dichotomously. Both variables are readily available in many intervention contexts.

Building from past research, we hypothesized that the explicit and implicit evaluations of fruit/vegetable consumption by cancer survivors would be weakly associated (a correlation below .20 [14]). Further, we anticipated that the relationship between these evaluations would become more divergent as time since initial cancer treatment increased and if the participant was treated for a prior cancer occurrence. The Affect Misattribution Paradigm (AMP) [11, 18], in which participants view prime images (e.g., fruits, vegetables) immediately prior to evaluating ambiguous images, was used to measure implicit associations. The rationale of the AMP is that if the primes evoke positivity or negativity, the ensuing evaluations of the ambiguous images will be unintentionally biased toward the valence of the prime—thus revealing implicit evaluations. The AMP is one of the most widely used implicit measures with established reliability and validity [18, 19].

Methods

Participants and Setting

One-hundred twenty-six cancer survivors presented for the study. This was the full sample. Four participants are not in final data analyses: one ended the study early, one failed to bring her glasses and could not complete the implicit task, and two were removed due to their knowledge of the ambiguous stimuli used in the implicit task, making the stimuli no longer ambiguous. Participants were cancer survivor patients at the Eleanor N. Dana Cancer Center, at the University of Toledo Medical Center, Toledo, Ohio. Participants (21 males, 101 females) ranging in age from 23 to 83 (M age = 57.32, SD = 11.51), the majority were White (82.8%) or Black (13.9%), and of the variety of cancer types, the most frequent was breast cancer (50.4%). Table 1 provides sample information. Written informed consent was obtained from all participants and all procedures were in accordance with the ethical standards of the University of Toledo Social, Behavioral and Educational IRB committee (IRB approval number: 200799), the guidelines of the American Psychological Associations, and with the 1964 Helsinki Declaration and its later amendments.

Table 1 Demographic characteristics of cancer survivors

Characteristics	$N = 122$	%
Age ($M = 57.32$; $SD = 11.51$)		
Less than 50	31	25.4
50 to 60	37	30.3
Over 60	54	44.3
Sex		
Female	101	82.8
Male	21	17.2
Race/Ethnicity*		
Caucasian	101	82.8
African American	17	13.9
Asian	2	1.6
Hispanic	4	3.2
American Indiana/Alaskan Native	1	.8
Unknown	1	.8
Native Hawaiian/other Pacific Islander	0	0
Length of time since treated for cancer ($M = 77.58$; SD = 76.06)		
Less than 70 months	69	57.02
70 to 120 months	27	22.31
Over 120 months	25	20.66
Is participant on diet?		
Yes	20	16.4
No	102	83.6
First time treated for cancer or not		
Yes	92	75.4
No	30	24.6
Main types of cancers		
Breast	63	50.4
Multiple cancers	14	11.2
Lymphoma	10	8.0
Other	35	28.7
BMI ($M = 29.46$; $SD = 6.98$)		
Less than 25	35	28.7
25 to 35	60	49.18
Over 35	27	22.13
Income		
Less than $15,000	11	8.8
$15,000 to $34,999	21	16
35,000 to $64,999	37	29.6
$65,000 to $79,000	13	10.4
$80,000 or higher	40	32.0

*Participants were allowed to select more than one race/ethnicity, thus the percentages do not sum to 100%

Procedure

As part of a project on education and nutrition [20], cancer survivors read and signed an informed consent document explaining they would be completing a study about fruits and vegetables. Participants answered self-reported questions on a computer using the survey program PsychData and completed the implicit evaluation task, the AMP [11], delivered through the software program DirectRT. When the study ended, participants were debriefed, thanked, and compensated with a $10 gift card.

Measures and Procedures

Only the pertinent measures are described here. In the entire set of study measures [20], both implicit ($\beta = .25$, $p = .002$) and explicit ($\beta = .17$, $p = .03$) fruit/vegetable evaluations significantly predicted fruit/vegetable consumption intentions. This suggests that both constructs have practical importance. The two evaluation measures, however, did not relate to past fruit/vegetable consumption.

Explicit Evaluation Measure Evaluations of fruit and vegetable consumption were provided following the prompts: "I believe that, for me, eating fruits is _____" and "I believe that, for me, eating vegetables is _____." Evaluations of both fruit and vegetables were made on six items: valuable, helpful, wise, beneficial, healthy, and desirable which were anchored from 1 (*not at all*) to 5 (*extremely*). Responses to the 12 items were averaged to create an explicit evaluation measure ($\alpha = .88$; $M = 4.6$; $SD = .91$). Although the mean is at the upper-end of the scale for this measure, it is consistent with scores in previous cancer survivor research [21].

Implicit Evaluation Measure Implicit evaluations of fruit and vegetables were assessed using the AMP. In the AMP, participants are presented with primes followed by ambiguous images. The rationale of the AMP is that individuals can misattribute their pleasant or unpleasant feeling toward the prime image to the ambiguous image, thus revealing their implicit feeling toward the primed category when they evaluate the ambiguous images. The key target prime images used were 40 different pictures of fruits and 40 different pictures of vegetables. Eighty target images, rather than a single target image, were presented to access the global concept rather than idiosyncratic responses of any specific image [18]. Neutral prime images used in past research [11] were presented as fillers. These neutral images were of common objects such as a lamppost and a cup. The target and neutral images were designed to be comparable in terms of size and clarity. Consistent with past AMP studies [11, 19], Chinese language characters, called Chinese pictographs (e.g., the pictograph for the English word tree is 木), served as the ambiguous images that followed the primes. Participants viewed 80 fruit and vegetable primes and 40 neutral control primes. In each trial, participants first viewed the prime image of a fruit or vegetable, or a neutral control prime for 75 ms. Next, the ambiguous image of a Chinese pictograph appeared on the screen for 100 ms

followed by a black and white static image for 125 ms. Finally, participants judged whether the Chinese pictograph was either "pleasant" or "unpleasant" using their keyboard. Following the standard scoring technique [11], AMP scores were calculated as the difference between the proportion of pleasant ratings on the fruit and vegetable trials and neutral trials. Higher values equate to more positive implicit ratings of fruit and vegetables ($M = .32$, $SD = .38$).

In past research, the AMP has demonstrated predictive validity, accounting for variance in behavior and in behavioral attentions across various domains (e.g., political action, eating, and substance use) [18]. In the present data, AMP scores predicted intentions to consume fruits/vegetables ($\beta = .25$, $p = .002$). The AMP also has established reliability. Across 45 studies, the AMP had split-half reliability of $\alpha = .81$ (95% CI = 0.77, 0.85) [18]. Internal reliability estimates are also high. For example, in a study using a food-based AMP task, internal reliability (Kuder-Richardson 20 [KR-20]) = .90 [19]. In the present study, the fruit/vegetable AMP images had high internal reliability, KR-20 = .96.

Potential Moderators The moderating variables were whether it was a participant's first time treated for cancer (prior cancer occurrence) and the time since their first cancer treatment (time since first treatment). The questions were worded as "Is this the first time you have been treated for cancer? If no, please explain." Participants provided a dichotomous answer of "YES" (75.4%) or "NO" (24.6%). The time since treatment variable was, "How long is it since you were first treated for cancer?" This had an open-ended fill-in text box in which the answers were later recorded in months (M months since treated = 77.58, $SD = 76.06$). These two moderating variables were significantly and positively correlated ($r = .41$, $p < .001$).

Demographic Variables Age, gender, ethnicity, race, smoking status, height and weight (to compute Body Mass Index [BMI]), and whether participants were on a diet were measured via self-report.

Data Analysis

Correlation coefficients were used to assess the simple associations between implicit evaluations and explicit evaluations of fruit/vegetable consumption. To test our predictions that amount of experience as a cancer survivor moderates the associations between implicit and explicit evaluations of fruit and vegetable consumption, we conducted two hierarchical linear regression analyses. The two regressions, one examining time since first treatment as a moderator and the other examining prior cancer occurrence as a moderator, were structured the same and followed prior research examining moderators of implicit and explicit evaluations [13]. In both regressions, age, gender, smoking status, BMI, and whether the participant was on a diet were included on a first step as covariates to ensure that these demographic variables were not responsible for any significant findings. In the first regression, implicit evaluation scores and length of time since first treatment were grand-mean centered and entered in the second step of the regression. In the third step of the model, the interaction of implicit evaluation scores and length of time since first treatment was entered. The criterion variable in the analysis was explicit evaluations of fruits and vegetables. The second hierarchical regression analysis was the same as the first, except that the dummy-coded dichotomous variable of whether participants had a prior cancer occurrence was used in place of time since first treatment. Finally, simple slope tests were conducted at + 1 and − 1 SDs of the predictor variables to determine if the association between implicit and explicit evaluations became more negative as cancer experience increased. The dataset for the current study is available from the corresponding author on request. All analyses were performed using SPSS 23.0 (IBM Corp, 2015).

Results

The Correlation Between Explicit and Implicit Evaluations The implicit and explicit evaluations were not significantly correlated, $r = -.05$, $p = .59$ (See Table 2).

Time Since First Cancer Treatment as a Moderator In the first regression analysis, step 1 did not account for significant variance in explicit fruit/vegetable evaluations, $R^2\Delta = .02$, $F(2, 114) = .49$, $p = .78$, with none of the covariates significantly predicting explicit evaluations. Step 2 also did not account for significant variance, $R^2\Delta < .01$, $F(2, 112) = .28$, $p = .76$, neither implicit evaluations ($\beta = -.03$, $p = .75$) and length of time since first treatment ($\beta = .07$, $p = .52$) predicting explicit evaluations. The third step of the model, which included the interaction term, did account for a significant proportion of variance, $R^2\Delta = .04$, $F(1, 111) = 4.89$, $p = .04$ (see Table 3). A visual display of this interaction is provided in Fig. 1, left panel. Simple slope tests indicated that when first cancer treatment was more recent, implicit and explicit evaluations were positively, but not significantly related, $\beta = .21$, $F(1, 111) = 2.37$, $p = .13$. However, as time since first treatment increased, this association reversed, with implicit and explicit evaluations demonstrating a negative relationship, $\beta = -.34$, $F(1, 111) = 4.97$, $p = .03$. These findings indicate that the implicit and explicit evaluations became more dissociated the longer the time since initial cancer treatment.

Prior Cancer Occurrence as a Moderator In the second regression, step 1 did not account for significant variance in explicit fruit/vegetable evaluations, $R^2\Delta < .02$, $F(2, 115) = .51$,

Table 2 Correlations among time since first treatment, prior cancer occurrence, implicit fruit/vegetable evaluations, and explicit fruit/vegetable evaluations

	Prior cancer occurrence	Implicit evaluations	Explicit evaluations
Time since first treatment	.410**	− .131	.050
Prior cancer occurrence	–	− .219*	.030
Implicit evaluations	–	–	− .049

*$p < .05$, **$p < .001$

$p = .77$, with none of the covariates significant predicting explicit evaluations. On step 2, both implicit evaluations ($\beta = -.03$, $p = .75$) and prior cancer occurrence ($\beta = .07$, $p = .52$) failed to predict explicit evaluations. The third step of the regression was significant, $R^2\Delta = .04$, $F(1, 112) = 4.39$, $p = .03$ (see Table 3). This interaction is depicted in Fig. 1, right panel. Simple slope tests indicated that when it was participants' first cancer occurrence, implicit and explicit evaluations were non-significantly associated, $\beta = .09$, $F(1, 112) = .07$, $p = .40$. For individuals with a prior cancer occurrence, however, implicit and explicit evaluations were significantly negatively related, $\beta = -.40$, $F(1, 112) = 4.05$, $p = .04$.

Conclusions

This research is the first to examine the association between the explicit and implicit evaluations of fruit/vegetable consumption of cancer survivors and the results found that the measures were not significantly correlated. This non-significant relationship is consistent with implicit and explicit findings in other domains [14]. As the measures were uncorrelated, and because implicit and explicit measures can have unique relationships with measures of health motivation and intentions [10], there may be utility in targeting both implicit and explicit fruit/vegetable evaluations. A broader implication

Table 3 Two hierarchical regression analyses with implicit evaluations and time since first treatment and implicit evaluations and prior cancer occurrence predicting explicit evaluations

Time since first treatment							
Model	β	SE	t	df	ΔR^2	F	p value
Step 1				114	.02	.49	.78
Participant age	− .07	.01	− .72				
Participant sex	.03	.16	.35				
Body mass index (BMI)	− .06	.01	− .64				
Smoking status	− .04	.12	− .41				
Dieting status	.11	.16	1.12				
Step 2				112	.005	.28	.76
Implicit evaluations	− .03	.16	− .32				
Time since first treatment	.07	.14	.65				
Step 3				111	.04	4.89*	.04
Implicit evaluations × time since first treatment	− .24	.37	− 2.1*				.04
Prior cancer occurrence							
Model	β	SE	t	df	ΔR^2	F	p value
Step 1				115	.02	.51	.77
Participant age	− .07	.01	− .74				
Participant sex	.05	.15	.48				
Body mass index (BMI)	− .05	.01	− .57				
Smoking status	− .04	.12	−.43				
Dieting status	.11	.16	1.13				
Step 2				113	.001	.33	.72
Implicit evaluations	− .03	.16	− .32				
Prior cancer occurrence	.07	.14	.07				
Step 3				112	.04	4.39*	.03
Implicit evaluations × prior cancer occurrence	− .24	.36	− 2.4*				.03

The covariates and explicit evaluations are self-reported

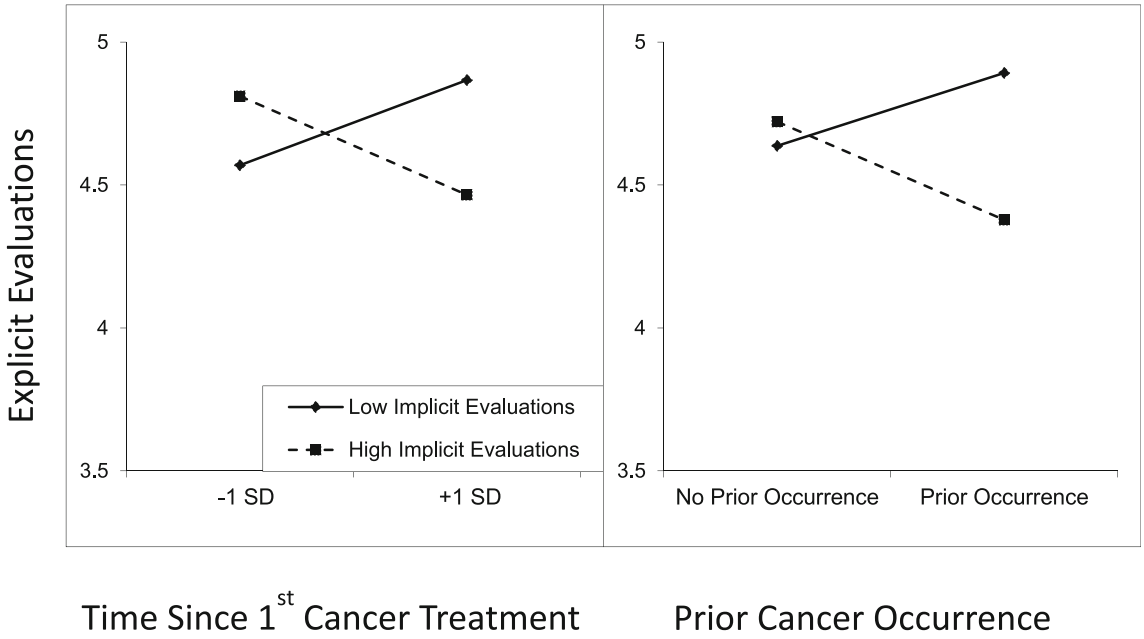

Fig. 1 Predicted values for explicit evaluations of fruit and vegetables as a function of implicit evaluations of fruits and vegetables and time since first cancer treatment (left panel) and prior cancer occurrences (right panel). Higher numbers indicate more positive evaluations of fruits and vegetables. Explicit evaluation scores on the *y*-axis can range from 1 to 5. The range is cropped in the figure to focus in on the interactions

of this divergence is that cancer survivors themselves, as well as interventionists, may be unaware that implicit negative evaluations of healthy behaviors are present and may be impeding health motivations and intentions.

Second, as time since treatment increased, implicit and explicit evaluations became significantly negatively related. This finding is consistent with studies showing that recent personally relevant experiences align implicit and explicit evaluations [16]. Furthermore, when participants had a prior cancer occurrence, implicit and explicit evaluations became significantly negatively related. This outcome is congruent with the supposition made at the outset that implicit and explicit evaluations achieve greater correspondence immediately following an initial diagnosis because thoughts related to one's diet appear more pressing and frequent in early survivorship [17]. At a theoretical level, the separation of implicit and explicit measures with cancer experience adds to the growing literature implicating experience in the moderation of implicit and explicit evaluations. Practically, it suggests that interventions may need to target both implicit and explicit evaluations when cancer experience is high. At the moment, it is unclear what caused the divergence. Perhaps cancer survivors change their dietary behaviors toward more nutritious eating which alters explicit but not implicit evaluations—as implicit evaluations can be more difficult to permanently shift [22]. Alternatively, eating nutritious food could become mentally paired with the concept of cancer over repeated association during anxious thought, resulting in the negativity of cancer becoming linked to eating nutritiously. Future research should explore these and other possibilities.

Study Limitations Study limitations include that the majority of participants were female and breast cancer survivors. These limitations constrain generalizability. Although we know of no existing data suggesting that the association between fruit and vegetable implicit and explicit evaluations would be altered by type of cancer, Egloff and Schmukle [23] found higher correlations between implicit and explicit measures of anxiety in women than men, suggesting there may be sex-related factors that influence responding on explicit versus implicit measures. Although it is unclear if these differences would extend to fruit and vegetable consumption, future research with a more even distribution of men and cancer types is certainly required to more extensively explore this concern, consistent with recommendations of Egloff and Schmukle [23]. Further, the study did not include a healthy control group nor a group with a different chronic disease. The specificity of the findings to cancer survivors is thus currently unknown and one should take caution in generalizing these findings to individuals with other chronic conditions. Consequently, future studies directly comparing implicit and explicit evaluation of fruit and vegetable consumption across additional groups are needed. Also, and most critically, our interpretations are limited by the use of a cross-sectional study design rather than a longitudinal design. Longitudinal designs with repeated measurements would allow researchers to directly track the association between implicit and explicit evaluations as experience as a cancer survivor increases. Finally, explicit evaluation scores were high which could have produced a ceiling effect and thereby reduced the implicit–explicit measure correlation. Additional studies are needed to provide more data on this issue.

Clinical Implications Implicit and explicit evaluations of fruit and vegetable consumption diverge for cancer survivors similar to implicit and explicit evaluations in other domains and samples [14]. To increase both positive implicit and explicit evaluations, one could draw specifically on existing theory and research on the interrelation of these evaluations to improve interventions that change cancer survivors' motives and intentions. Consistent with this view, the present findings suggest that implicit and explicit evaluations of fruit/vegetables shift due to experience with cancer and that interventionists attempting to improve these evaluations may need to account for these changes. Future clinical research should examine implicit evaluations as an avenue to improve the health of cancer survivors.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the University of Toledo Social, Behavioral and Educational IRB committee (IRB approval number: 200799), the guidelines of the American Psychological Associations, and with the 1964 Helsinki Declaration and its later amendments.

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