Optimism and the Experience of Pain

BEHAVIORAL MEDICINE
2019, VOL. 45, NO. 4, 323–339
https://doi.org/10.1080/08964289.2018.1517242

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REVIEW

Optimism and the Experience of Pain: A Systematic Review

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ABSTRACT

A growing body of literature provides evidence of the health-promoting effects of optimism, including its protective role in acute and chronic pain. Optimists are characterized by positive expectations concerning the future. These positive outcome expectancies lead to more and longer goal-directed efforts and the use of approach coping strategies. No systematic review on the effects of optimism on the experience of pain has so far been conducted. A search in the databases PubMed, Web of Science and PsycInfo, and the scanning of reference lists identified 69 eligible studies. These were categorized according to sample size, participants' age and sex, design, optimism-pain relation as primary vs. secondary study objective, and level of study/publication quality. Overall percentages of positive, zero, and negative associations between optimism and pain as well as relative frequencies of these associations in the different categories were analyzed. About 70% of the studies showed a positive, i.e., beneficial association between optimism and at least one pain outcome. A larger percentage of beneficial associations was found in studies with experimental designs, in studies with the optimism-pain relation as primary objective, in high-quality studies/publications, and in studies including participants with a higher average age. The review suggests that optimism is associated with less acute and chronic pain, especially since a higher percentage of beneficial associations was found with high study/publication quality and with the primary focus on this relationship. For the moderating role of age, different explanations are proposed. Further research on causal relationships and on optimism-fostering clinical interventions is needed.

KEYWORDS

chronic pain; optimism; pain; positive psychology; resilience

Introduction

For decades, pain research has been dominated by the examination of risk factors. Only recently, in the wake of Antonovsky's *salutogenic model*[1] and Martin Seligman's work in positive psychology,[2] this traditional focus has been extended to the search for resilience factors, i.e. factors that can dampen acute pain experience, promote adaptation to chronic pain, or protect against developing chronic pain. Self-efficacy, hope, and positive affect are among these characteristics that have been shown to promote pain resilience.[3,4]

As stated in the fear-avoidance model of musculoskeletal pain,[5] chronic pain can be a result of a dysfunctional psychological reaction to an acute pain experience. People who tend to engage in catastrophizing thoughts concerning their pain are likely to get caught in a vicious circle of fear of pain, avoidance and hypervigilance, disuse and disability, and in turn increased pain. Optimism seems to protect against the development of this vicious circle leading to chronic pain in that it stops catastrophizing and hypervigilance to negative information, as will be described. Originally defined by Scheier and Carver as "generalized positive outcome expectancies"[6] in the context of their theory of self-regulation,[7] optimism describes the tendency of individuals to expect positive things to happen to them in the future. As optimists subjectively evaluate the probability of success higher, they are more likely to engage and persist in goal-directed efforts (as opposed to the "why-bother"-attitude of pessimists),[8] which in turn increases their chance to effectively cope with stressors.[9] This is in line with traditional *expectancy x value*-theories of motivation,[10] which emphasize the role of expectations in motivation and motivated behavior.

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There is evidence of a wide range of health-promoting effects of optimism (for a comprehensive overview, see Carver et al.;[11] for a recent mini review concerning chronic diseases, see Avvenuti et al.[12]). Although the association of optimism with *pain* has been examined in numerous studies, no systematic review or meta-analysis has to our knowledge been published on this topic.

Apart from several overviews covering related topics such as the relationship between pain and positive traits[3] or between optimism and coping,[13] there have been two publications on the topic of optimism and the experience of pain: Garofalo's review on perceived optimism and chronic pain, covering the literature until 2000,[8] and Goodin and Bulls' review on optimism and the experience of pain incorporating research from 2000 to 2013.[9] Although being valuable sources of information, the two publications lack the methodic and scrupulous approach of *systematic* reviews.

Garofalo,[8] limiting his review to chronic pain conditions, concluded that the body of literature available at that time was too scant for definite conclusions, but tentatively suggested positive effects of optimism on chronic pain. Goodin and Bulls,[9] who were able to make inferences from a significantly larger number of studies, confirmed these findings, extending them to experimental pain conditions. They also listed several cognitive and behavioral mediators that are associated with less severe pain reports and therefore might explain the underlying mechanisms of the optimism-pain relationship: optimists tend to show lower pain catastrophizing (see Pulvers and Hood,[3] for an overview), higher hopefulness and pain acceptance and more effective coping strategies.

The present overview adds to and extends this previous work in that it uses a research algorithm in order to systematically retrieve all relevant studies on the optimism-pain relationship, covering experimental and clinical pain as well as dispositional and situational optimism. It is thus the first to give a comprehensive account of the current state of research. Additionally, in order to propose explanations for divergent results, we seek to identify variables which influence whether a study finds a significant association; that is, moderating factors of the optimism-pain relation. In the pain context, sex and age have been shown to be among the most important moderating variables.[14,15] Accordingly, for men and women differential relations between optimism and various health-related variables like, for example, stress symptoms have been reported.[6,16] Similarly, there is evidence of age effects in the prediction of self-rated health by several psychological variables such as positive affect or depressive symptoms (for example, Spuling et al.,[17] Benyamini et al.,[18] French et al.[19]). In these studies, the influence of psychological as compared to physiological variables augmented with increasing age. It can therefore be speculated that likewise optimism's association with pain might be bigger in older individuals. For this reason, age will be analyzed as another possible moderating variable. The probability that an existing association between optimism and pain is statistically detected also depends on parameters of study design. Studies with large sample sizes have more statistical power. In experimental studies, confounding variables can more easily be ruled out. Studies focusing on optimism and pain as their primary aim can be supposed to be tailored to more accurately measure the two variables of interest. Therefore, these technical variables as well as an overall measure of study/publication quality are included in the set of variables possibly influencing the optimism-pain relation.

So far, optimism has largely been conceptualized as a personality disposition measured by trait questionnaires, especially the *Life Orientation Test* (*LOT*)[6] and its revised version (*LOT-R*),[20] which offer both a composite optimism score and separate scores on optimism and pessimism subscales.

Only recently, attempts have been made to experimentally induce an optimistic state for a short while. Fosnaugh and colleagues described significant positive changes in a dispositional (*LOT-R*) and a comparative optimism measure both after a future thinking manipulation and after a semantic optimism-priming task.[21] Peters and associates[22] as well as Hanssen and researchers[23] reported positive evidence obtained by a different manipulation, the *Best-Possible-Self*-task (BPS).[24] During this exercise, participants imagine and write about themselves in the future, when they envision to have reached all their goals, and when all their dreams have become true (for the exact instructions, see supplement 2).[25] The BPS was shown to be successful in bringing about an increase in participants' situational optimism, which was recorded by the *Questionnaire for Future Expectations (FEX)*, an adaptation of the *Subjective Probability Task*.[26]

In the present work, both studies using experimental pain and studies of clinical pain are reviewed. As the theoretical framework on optimism claims that optimism has a trait (dispositional) as well as a state (situational) component,[27] we will consider trait as well as state measures of optimism, which are known

to be highly correlated,[28] and include induced (experimentally or through clinical interventions) as well as spontaneous (non-induced) optimism. As implied by Carver and Scheier's definition,[6] optimism concerns *generalized* outcome expectations, which is why specific expectations (e.g., health-related beliefs) are not considered here as a measure of optimism.

Since there are many different pain-related variables, it seems reasonable to focus first on pain experience in the narrow sense, which comprises reports of pain intensity, frequency or unpleasantness, the measurement of pain thresholds, pain tolerance thresholds, and psycho-physiological parameters like evoked potentials or heart rate responses. Also considered are parameters, which can be derived from the first group of parameters such as habituation, temporal summation, conditioned pain modulation, or placebo/nocebo effects. Due to the growing number of methodological approaches to assess pain and its various dimensions, it is not possible to incorporate all different pain outcome variables into one review. Thus, it seemed reasonable to focus only on the basic variables of pain experience in this first overview. Secondary pain outcomes such as fear of pain, pain-related disability, functional impairment, coping with pain, or adjustment to pain conditions are not included here, but may be considered in further reviews.

It is, in summary, our aim to provide an overview of a topic of high clinical relevance, the association of optimism with pain experience. We set out for the first time to systematically review research on the optimism-pain-relation in order to propose answers to the following questions: Is optimism associated with less pain and, if yes, under which conditions is this association observed?

Methods

The present article is based on the recommendations of the PRISMA guidelines for the creation of systematic reviews and meta-analyses.[29] The studies included in this review were identified through a computerized search in the databases *PubMed, Web of Science* and *PsycInfo,* which cover a large part of research articles in the field of psychology and medicine and have been used in previous reviews on similar or related topics.[3,30] A search algorithm combining keywords referring to pain (such as "pain," "clinical pain," "experimental pain," "pain intensity," "pain threshold," etc.) with keywords referring to optimism (such as "optimism," "dispositional optimism," "situational optimism") was employed. Due to the known differences of pain perception between adults and children[31] we decided to exclude pain in children and focus on adult humans. Therefore, "children" as well as "animals" were applied as NOT-terms (for the exact syntax used for the search, see supplement 1). There were no restrictions concerning years of publication. Five additional relevant studies from other sources, for example, scanning of reference lists, were added (see Figure 1). Titles and abstracts of the 675 studies retrieved via this systematic search were screened. Five hundred forty records had to be excluded because they were either not related to the topic of pain and optimism or they were records in a language other than English, reviews or no peer-reviewed journal articles. Of the 135 articles assessed in full-text for eligibility by two reviewers, only those were included in our synthesis which fulfilled the following three conditions: (1) involving the exact variables of interests—pain and optimism rather than related constructs such as hope; (2) providing distinct measures of both optimism and pain (within the same person, thus precluding studies treating concepts like "caregiver optimism") in order extract the specific values of these two constructs; (3) reporting some form of statistical measure of the relation between both constructs (e.g., correlation, effect size in ANOVA or regression; regressions of optimism on pain were excluded on the basis of our research question).

For a methodological study/publication description, the 69 studies meeting all inclusion criteria (see Table 1) were assessed using an index of quality, inspired by assessment tools for studies in meta-analyses such as the *Newcastle-Ottawa scale*,[32] which provide an operationalized score for each study. Lower levels of quality in the respective categories (e.g., no clear description of measures, missing documentation of comorbidity) are awarded fewer points (see Table 2). The quality of each study/publication could range from a minimum of 1.5 points to a maximum of 11 points. Based on our theoretical assumptions on potential moderating variables described in the introduction, we classified all studies according to age of subjects (following Erikson's[33] categorization), sex of subjects, sample size, design (clinical-cross-sectional vs. clinical-longitudinal vs. experimental), importance of the optimism-pain relation within the study (among the primary objectives of the study or not), and the previously mentioned quality index. The included pain measures reflect different dimensions (e.g., pain intensity, unpleasantness, threshold, tolerance, duration) and can therefore not sensibly be aggregated. For this reason, it was not possible to

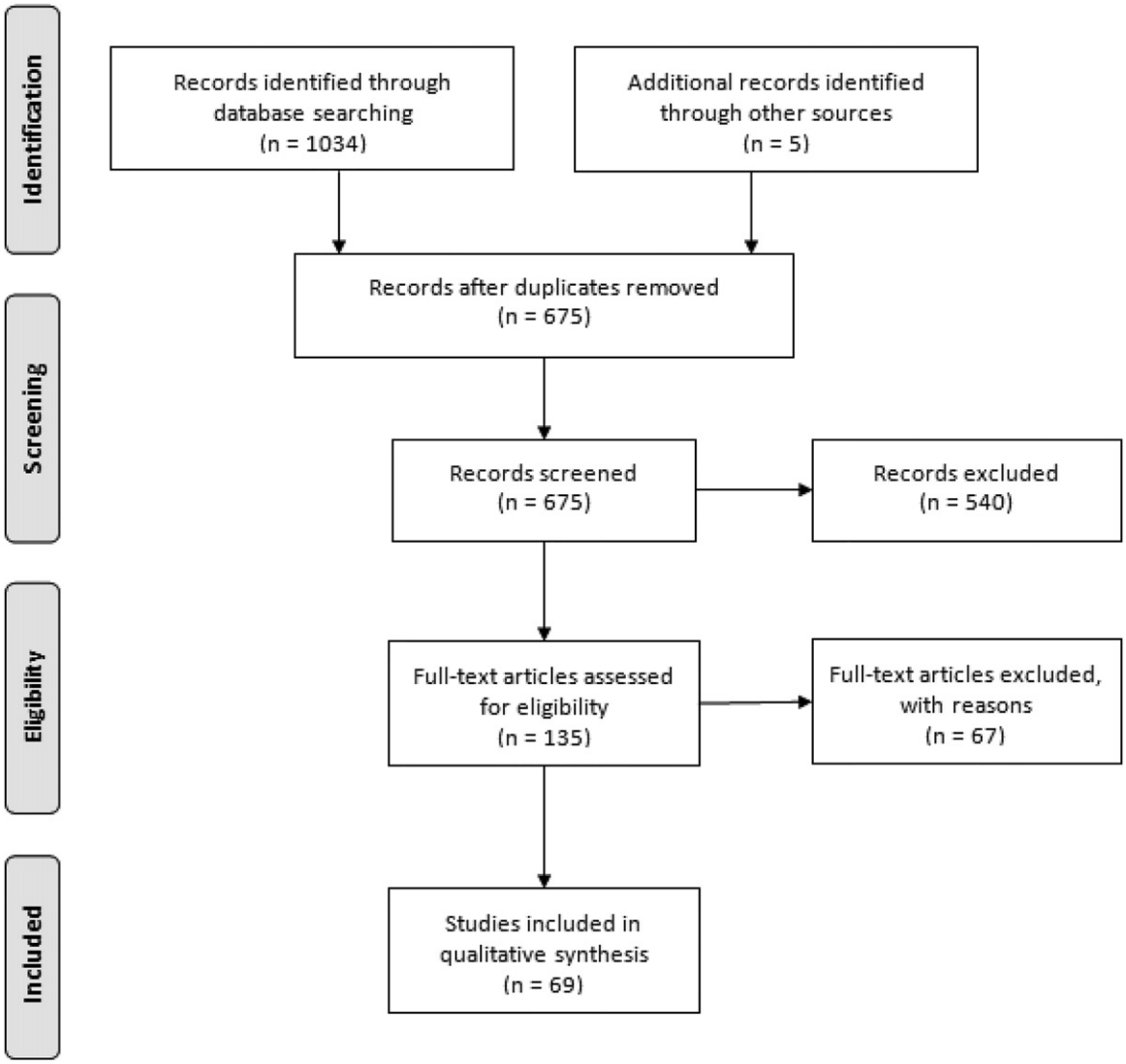

Figure 1. Flow chart illustrating the selection of studies for the review according to the PRISMA guidelines.

perform a meta-analysis incorporating the whole sample of studies.

We analyzed for each moderating variable the percentage of studies with positive (i.e., significant beneficial association between optimism and pain)[1] versus not positive results in the different classes of this variable (e.g., different age groups). Due to the numerous cell frequencies of $n < 5$ in the resulting multi-field panels, we did not perform chi^2 tests, but instead tested for significant deviations from an equal distribution with binominal tests.

Results

Descriptive statistics

Of the 69 studies included in the review, 55 dealt with clinical pain,[34–88] 12 with experimental pain,[23,89–99] and two[100,101] with both of them (cf. Tables 1 and 3).

Clinical Studies: Most studies concerning clinical conditions had participants with either musculoskeletal pain ($k = 10$)[2], arthritis ($k = 10$) or post-operative pain ($k = 17$). Another seven articles dealt with different forms of cancer pain, the remaining eleven studies with various other clinical conditions, which are listed in detail in Table 1. To assess pain, the clinical studies used questionnaires—mostly the *SF-36* ($k = 7$), the *MPQ* and its short form ($k = 5$), the *BPI(-SF)* ($k = 7$) or illness-specific questionnaires ($k = 12$) as, for example, the *RADAR*—and/or rating scales ($k = 24$).

Experimental Studies: In experimental settings, the majority of the 14 studies used the cold pressor task ($k = 8$). Three studies applied laser ($k = 1$) or thermode-induced ($k = 3$) heat pain. The remaining three studies used thermode-induced cold pain ($k = 1$), chemical ($k = 1$) and ischemic ($k = 1$) pain. Pain

Table 1. Studies comprised in the review.

	Authors (Year)	Sample Size	Age			Type of Pain (Pain-Causing Method/Event/ Medical Condition)		Optimism Measure	Design			Result (Type of Association)			Quality Points	Among Primary Objectives
			Ø <30	Ø 30-60	Ø >60	*Experimental*	*Clinical*		*Cross-sectional*	*Longitudinal*	*Experimental*	*Beneficial*	*Zero*	*Non-beneficial*		
34	Achat et al. (2000)*	659	?	?	?	–	x	LOT	x	–	–	x	–	–	6.5	x
35	Airila et al. (2014)	360		x		–	multiside musculoskeletal pain	single item	–	x	–	–	x	–	7	?
36	Allison et al. (2000)	88		x		–	head and neck cancer	LOT	–	x	–	x	–	–	8	x
37	Bediako et al. (2011)	83		x		–	sickle-cell disease	LOT-R	x	–	–	x	–	–	8	–
38	Bentsen et al. (2008)	101		x		–	chronic low back pain after spinal fusion	single item	x	–	–	x	–	–	7.5	x
39	Benyamini (2005)	120			x	–	osteoarthritis	LOT	–	x	–	x	–	–	9	–
40	Booth-Kewley et al. (2014)	134	x			–	musculoskeletal injuries	LOT-R	–	x	–	–	x	–	9	x
89	Boselie et al. (2014)**	74	x			cold pressor task	–	LOT-R; FEX	–	–	x	–	x	–	8	–
41	Brewer et al. (2007)	91	x			–	anterior cruciate ligament reconstruction	LOT-R	–	x	–	–	x	–	8	x
42	Bruce et al. (2012)	338		x		–	breast cancer surgery	LOT SF	–	x	–	x	–	–	8	x
43	Bruce et al. (2014)	338		x		–	breast cancer surgery	LOT SF	–	x	–	x	x	–	8	x
44	Callahan (2000)	163		x		–	temporomandibular disorders	LOT	x	–	–	x	–	–	7.5	x
45	Chamberlain et al. (1992)	57			x	–	surgery for joint replacement	LOT	–	x	–	x	x	–	8	x
46	Chrisler et al. (2006)	92	x			–	menstrual pain	LOT	x	–	–	x	–	–	7	–
47	Coronado (2017)	63		*x*		–	shoulder pain	LOT-R	–	*x*	–	–	*x*	–	8.5	*x*
90	Corsi et al. (2017)	46	*x*			heat	–	LOT-R	–	–	*x*	–	*x*	–	9.5	*x*
100	Costello et al. (2002)	48	x			ischemic pain	temporomandibular disorders	LOT	–	–	x	x	x	–	9.5	x
91	Dimova et al. (2015)	110	?	?	?	capsaicin	–	LOT-R	–	–	x	x	–	–	10.5	x
48	Ferreira et al. (2007)	72			x	–	osteoarthritis	LOT-R	x	–	–	x	–	–	7.5	x
49	Fishbain et al. (2001)	637	?	?	?	–	myofascial pain syndrome	PAS	x	–	–	x	x	–	7	–
50	Fitzgerald et al. (1993)	49			x	–	coronary artery bypass surgery	LOT	–	x	–	x	x	–	7	x
92	Geers et al. (2010)	116	x			cold pressor task	–	LOT-R	–	–	x	x	–	–	9	x
93	Geers et al. (2008)	72	x			cold pressor task	–	LOT-R	–	–	x	x	x	–	9	x
101	Goodin et al. (2013a)	100		x		heat	knee osteoarthritis	LOT-R	–	–	x	x	x	–	10	x
94	Goodin et al. (2013b)	149	x			cold pressor task	–	LOT-R	–	–	x	x	x	–	11	x
51	Gramke et al. (2009)	648	?	?	?	–	day-case surgery	LOT	–	x	–	–	x	–	9	x
23	Hanssen et al. (2013)**	79	x			cold pressor task	–	LOT-R; FEX	–	–	x	x	–	–	8	x
95	Hanssen et al. (2014)	60	x			cold pressor task	–	LOT-R	–	–	x	x	x	–	8.5	x
52	Hetmann et al. (2015)	106			x	–	thoracotomy	LOT-R	–	x	–	x	–	–	9.5	x
96	Hood et al. (2012)	114		x		cold pressor task	–	LOT-R	–	–	x	x	–	–	9.5	x
53	Hoofwijk et al. (2015)	908		x		–	outpatient surgery	4 items of LOT	–	x	–	x	–	–	9.5	x
54	Katz et al. (2016)	164		x		–	inflammatory bowel disease	LOT-R	x	–	–	–	x	–	9	–
55	Kurtz et al. (2008)	214		x		–	during chemotherapy	LOT	–	x	–	x	–	–	8	x
56	Lam et al. (2012)	253		x		–	nasopharynegeal cancer	single item	–	x	–	–	x	–	7	–
57	Langbach et al. (2016)	265		x		–	hernia and hernia repair	LOT-R	–	x	–	x	x	–	9.5	x
58	Lau et al. (2008)	5163		x		–	x	1 item of LOT	–	x	–	x	–	–	7.5	x
59	Long et al. (1993)	200			x	–	rheumatoid arthritis/ osteoarthritis	LOT	x	–	–	–	x	–	8.5	–

(*Continued*)

Table 1. Continued.

	Authors (Year)	Sample Size	Age			Type of Pain (Pain-Causing Method/Event/ Medical Condition)		Optimism Measure	Design			Result (Type of Association)			Quality Points	Among Primary Objectives
			Ø <30	Ø 30-60	Ø >60	*Experimental*	*Clinical*		*Cross-sectional*	*Longitudinal*	*Experimental*	*Beneficial*	*Zero*	*Non-beneficial*		
60	Mahler et al. (2000)	215			x	–	coronary bypass surgery	LOT	–	x	–	x	–	–	10	x
97	Morton et al. (2009)	62	x			laser heat	–	LOT-R	–	–	x	x	x	–	8.5	x
61	Mueller et al. (2003)	148		x		–	fibromyalgia	4 items	x	–	–	–	x	–	7	–
62	Pence et al. (2007)	27	x			–	sickle-cell disease	LOT-R	–	x	–	–	x	–	8.5	–
63	Peters et al. (2007)	625		x		–	surgery	LOT	x	–	–	–	x	–	8	x
64	Peters et al. (2010)	401		x		–	elective surgery	LOT	–	x	–	–	x	–	9	x
65	Pinto et al. (2015)	252		x		–	hysterectomy/ joint arthroplasty	LOT-R	–	x	–	x	x	–	7	x
66	Pinto et al. (2017)	124			x	–	hip and knee arthroplasty	LOT-R	–	x	–	x	x	–	9.5	x
67	Pinto et al. (2014)	110			x	–	major joint arthroplasty	LOT-R	–	x	–	x	–	–	10	–
68	Pinto et al. (2013)	124			x	–	primary total hip/ knee arthroplasty	LOT-R	–	x	–	x	–	–	9	x
69	Powell et al. (2012)	135			x	–	inguinal hernia repair surgery	2 items of LOT	–	x	–	x	–	–	7.5	x
70	Pulgar et al. (2015)	69	?	?	?	–	hematological cancer	LOT	x	–	–	–	x	–	7	x
71	Ramírez-Maestre et al. (2012)	98		x		–	chronic pain	LOT	x	–	–	–	x	–	7.5	x
72	Ronaldson et al. (2014)	197			x	–	coronary artery bypass graft surgery	LOT-R	–	x	–	x	x	–	9	x
73	Rosenberger et al. (2009)	180		x		–	arthroscopic knee surgery	LOT-R	–	x	–	x	x	–	9.5	x
74	Saariaho et al. (2011)	602		x		–	chronic pain	EMS	x	–	–	x	–	–	8	x
75	Sherman et al. (2013)	160			x	–	osteoarthritis	LOT-R	x	–	–	x	x	–	8	–
76	Singh et al. (2010)	1449			x	–	knee replacement	MMPI	–	x	–	x	–	–	8	x
77	Sipilä et al. (2009)	5696	?	?	?	–	temporomandibular disorders	LOT-R	x	–	–	x	–	–	8	x
78	Smith et al. (2008)	170			x	–	rheumatoid arthritis/ osteoarthritis	LOT-R	–	x	–	–	x	–	8	–
98	Smith et al. (2009)	47		x		heat and cold	–	LOT	–	–	x	x	x	–	8.5	x
99	Snyder et al. (2005)	116	x			cold pressor task	–	LOT-R	–	–	x	–	x	–	8.5	x
79	Söderlund et al. (1999)	104		x		–	whiplash associated disorders	LOT	x	–	–	–	x	–	7.5	x
80	Sorbi et al. (2006)	80		x		–	chronic pain	single item	–	x	–	x	–	–	8.5	x
81	Stessel et al. (2017)	1118		x		–	day surgery	4 items of LOT-R	–	*x*	–	*x*	–	–	9.5	–
82	Su et al. (2017)	320		x		–	temporomandibular disorders	LOT-R	x	–	–	x	x	–	7.5	*x*
83	Tennen et al. (1992)	54		x		–	rheumatoid arthritis	LOT	–	x	–	x	x	–	7.5	–
84	Treharne et al. (2005)	154		x		–	rheumatoid arthritis	LOT	–	x	–	x	x	x	8.5	x
85	Tsakogia et al. (2011)	96		x		–	chronic musculoskeletal pain	LOT-R	x	–	–	x	–	–	8	x
86	Wiesmann et al. (2014)	387			x	–	x	LOT	x	–	–	x	x	–	8	x
87	Wong et al. (2007)	334			x	–	lung cancer	single item	–	x	–	x	x	–	7	x
88	Wright et al. (2011)	89		x		–	chronic musculoskeletal pain	LOT-R	x	–	–	–	x	–	8	x

*numbers are identical to those by which the studies are designated in the text.
**experimental optimism induction.

Table 2. Quality index applied for the selected studies.

Category		*Points*
Sample size	small (n < 50)	0.5
	medium (n= 50-100)	1
	large (n > 100)	1.5
Sex	not reported	0
	one sex only	0.5
	both sexes, not well-balanced	1
	well-balanced ratio (max. 40:60)	1.5
Age	not well documented	0
	moderately well documented (e.g., range OR average)	0.5
	well documented	1
Type of pain	unclear description	0
	sufficiently clear description	1
Description of pain measure	unclear description	0
	sufficiently clear description	1
Type of pain measure	health measure including a pain-item	0.5
	specific pain measure	1
Measure of optimism	single item	0
	more than one item out of validated questionnaire	0.5
	validated questionnaire	1
Medication	not reported	0
	moderately well specified	0.5
	precisely described	1
Comorbidity	not reported	0
	moderately well specified	0.5
	precisely described	1
Design	cross-sectional	0.5
	longitudinal/experimental	1

Table 3. Summary of types of pain and pain measures in the 69 reviewed studies.

	Clinical pain	*K*	Experimental pain	*k*
Type of pain	musculoskeletal pain	10	cold pressor task	8
	arthritis pain	10	laser heat pain	1
	post-operative pain	17	thermode heat pain	3
	cancer pain	7	chemical pain	1
	other	11	ischemic pain	1
Pain measure	questionnaires		rating of intensity	11
	• SF-36	7	rating of unpleasantness	4
	• MPQ(-SF)	5	pain threshold	4
	• BPI(-SF)	7	tolerance threshold	6
	• illness-specific (f.ex. RADAR)	12	CPM & TS	2
	rating scales	24	habituation	1
			placebo analgesia	2

experience was determined by recording reports of intensity (k = 11) and unpleasantness (k = 4), pain thresholds (k = 4) or pain tolerance thresholds (k = 6). From these, some studies computed markers of inhibitory or facilitatory processes (conditioned pain modulation or temporal summation, k = 2), habituation (k = 1) and placebo analgesia (k = 2). As only three articles included psycho-physiological and stress parameters (blood pressure and heart rate[92,93] and the pro-inflammatory cytokine interleukin-6[100]), we did not perform any separate analyses with these outcome measures.

Optimism Measure: All but nine studies (k = 60) fully or partly employed the same optimism measure, namely the *LOT* or *LOT-R*. In five studies, measurement of optimism was limited to a single item, which in one case was taken from the *LOT*. One study took two items from the *LOT*, the remaining three studies used other scales (*PAS*, *EMS* and *MMPI*). All of the measures concerned dispositional optimism. The two studies which conducted an experimental induction of optimism[23,89] additionally recorded situational optimism (measured by the *FEX*).

Sample Size: Sample sizes ranged from 27 to 5,696.

Sex: The majority of the studies (k = 62) included both sexes; five studies had only female and two studies only male participants.

Age: As several reports (k = 5) did not specify participants' age, no exact indication of the average or range of age can be made. Of the studies where age was reported, about half (k = 33) had an average between 30 and 60 years, 22% (k = 14) younger than 30 years, and 27% (k = 17) older than 60 years. In experimental studies, the average age seems to be younger than 30 years (27.9 in studies that reported average age); in clinical studies, the mean of specified age averages was 53.6 years.

Study/Publication Quality: Quality according to the index we applied (see Table 2) ranged from 6 to 11 points in the present studies. Only one article[94] scored the maximum of 11 quality points.

(Co)morbidity: In more than half of the studies (k = 36), morbidity or comorbidity was not reported. Most experimental designs excluded illnesses that are known to influence pain perception. In at least 10 clinical studies, a part of the participants was affected by major illnesses such as depression or diabetes.

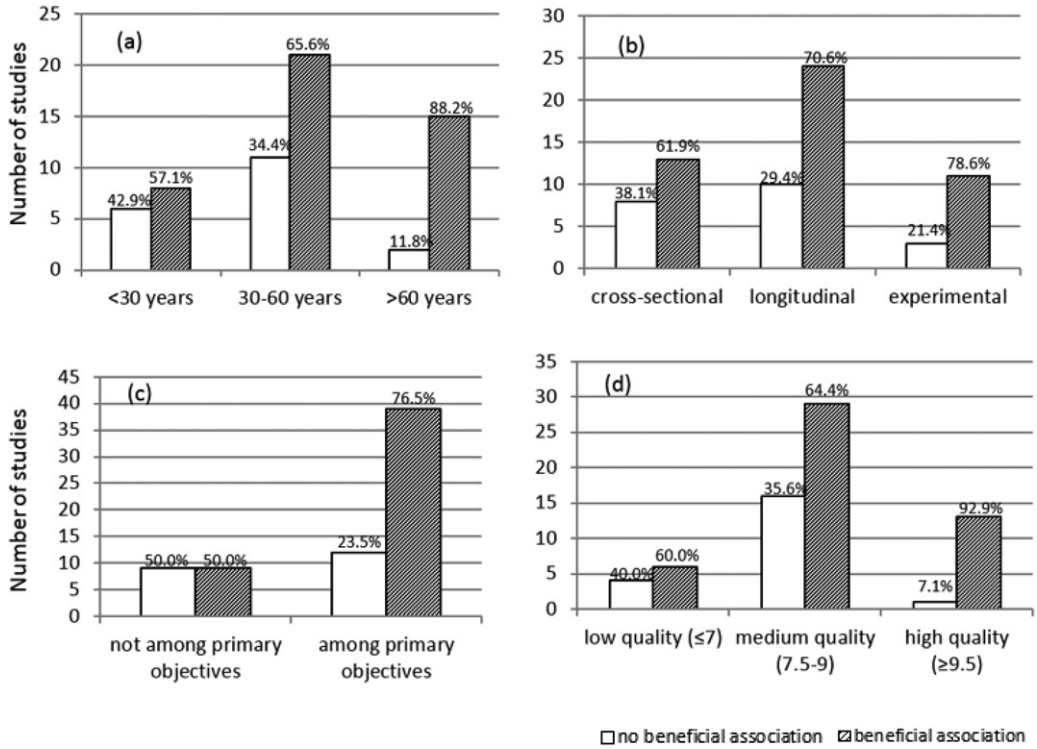

Figure 2. Possible moderating variables of the optimism-pain relationship: (a) age, (b) type of design, (c) relevance of the relation within the study, (d) level of quality.

Optimism-pain relation

In total, 48 of the 69 studies (69.6%) found a significant beneficial association between optimism and at least one pain outcome. Of those, 25 studies (36.2% of all 69 studies) revealed an exclusively beneficial—no additional zero or negative association. The remaining 23 studies (33.3% of all 69 studies) showed mixed results which means that they report two or more outcome measures with diverging results (see Table 1). These different results partly stem from different statistical analyses of the same data: in some cases, for example, simple correlations or univariate regressions were significantly positive, while the association disappeared in more complex models such as hierarchical regressions or multivariate models.[82,83,86] Apart from that, "mixed results" also refers to diverging results for subgroups of the sample (e.g., men vs. women,[49] different experimental conditions,[93] clinical population vs. healthy controls),[100] for different optimism parameters (e.g., subscales of the LOT),[75] for different pain outcomes (e.g., pain intensity vs. pain tolerance or pain threshold;[78,95] clinical vs. experimental pain;[101] different types of clinical pain)[57,65,66] or for different times of measurement (first vs. second experimental session;[97] baseline vs. follow-up).[50,73,87]

Twenty-one studies (30.4% of all 69 studies) did not detect any association; one study[84] reports a negative association for one subgroup of the sample (patients with established rheumatoid arthritis), beneficial associations for the other two subgroups (early and intermediate rheumatoid arthritis) and no association between optimism and pain in the overall correlation.

Moderating variables

Sample Size: 72.3% (k = 47 of 65) of studies with medium (n= 50–100) or large (n > 100) sample sizes report a beneficial association between optimism and at least one pain outcome. Since there were only a few studies with small sample sizes (k = 4), we are not able to draw any general conclusions about the impact of sample size on the likelihood of positive findings.

Age: As shown in Figure 2, the proportion of studies showing beneficial associations increases with higher age. Thus, 88.2% (k = 15 of 17) of studies with an average age above 60 years revealed significant beneficial associations, compared to 65.6% (k = 21 of 32) and 57.1% (k = 8 of 14) in the age groups of 30–60 years and under 30 years, respectively. Binominal tests showed that there were significantly more beneficial than zero associations in the two older age groups (30–60 years: $p = 0.03$; above 60: $p < 0.005$), but not in the youngest one ($p = 0.18$).

Sex: Due to the too small number of studies including either exclusively women or men or explicitly testing for sex differences (k = 8), no conclusions can be derived concerning the moderating role of sex.

Design: While both experimental and clinical studies show a clear majority of beneficial over zero associations, this tendency becomes more apparent in experimental designs, where beneficial associations are reported in 78.6% (k = 11 of 14) of studies, compared to 70.6% (k = 24 of 34) in clinical-longitudinal and 61.9% (k = 13 of 21) in clinical-cross-sectional studies (see Figure 2). The proportion of beneficial associations was significantly larger than an equal distribution in the former two (experimental: $p = 0.02$; clinical-longitudinal: $p = 0.01$), but not in clinical-cross-sectional designs ($p = 0.10$).

Optimism as Primary Objective: As there were studies whose major focus was set on examining the relationship between optimism and pain experience as opposed to others in which optimism was one of a multitude of psychological variables measured and pain one of health-related outcomes, we analyzed separately those studies that treated the optimism-pain relation as primary vs. secondary objective. While in the latter group, only half of the studies (k = 9 of 18; $p = 0.19$) found a positive optimism-pain association, studies focusing on optimism and pain yielded beneficial associations at 76.5% (k = 39 of 51; $p < 0.005$) and thus significantly more often than expected under an equal distribution (see Figure 2).

Study/Publication Quality: Eventually, regarding quality of study and publication as a possible moderating factor, our analysis showed a markedly higher percentage of beneficial associations with high study/publication quality (quality index ≥9.5): as shown in Figure 2, 92.9% of the studies in this group (k = 13 of 14) report a beneficial association between optimism and at least one pain outcome, compared to 60% (k = 6 of 10) of records with low study/publication quality (≤ 7 points) and 64.4% (k = 29 of 45) of records with medium study/publication quality (7.5–9 points). The proportion of beneficial associations was significantly bigger than expected under an equal distribution in the medium ($p = 0.02$) and high-quality group ($p < 0.005$), but not in the low quality group ($p = 0.20$).

Discussion

The present systematic review on studies investigating the relation between optimism and the experience of pain is the first of its kind. Optimism was defined as generalized expectations concerning the future, including trait and state measures. Pain experience according to our definition included reports of pain intensity, frequency or unpleasantness, the measurement of pain thresholds, pain tolerance thresholds and psycho-physiological parameters as well as higher-ordered pain processes like habituation, temporal summation, conditioned pain modulation or placebo/nocebo effects.

Of the 69 eligible articles comprising experimental and clinical studies with a variety of different types and measures of pain, about 70% (k = 48) showed a beneficial association regarding at least one pain outcome measure. A significantly bigger proportion of beneficial associations than expected under an equal distribution of was found in experimental and clinical-longitudinal studies, studies with the major focus on the optimism-pain relation, studies with high study/publication quality as well as studies with a higher average age of the participants. All in all, the present state of research suggests that optimism can indeed be considered a psychological factor which is associated with a diminished experience of pain one of several health-related outcomes.

Moderating variables

In order to determine why some studies found significant beneficial associations while others did not, we examined several moderating factors of the optimism-pain relation.

Experimental and clinical-longitudinal designs, studies with the optimism-pain relation as primary objective and studies with a higher study/publication quality were shown to produce a significantly larger percentage of beneficial associations than expected under an equal distribution. This seems to further corroborate our assumption of a beneficial optimism-pain relationship, since these are studies which are more likely to detect an association if it does exist: studies with high study/publication quality presumably yield more valid data than studies with low study/publication quality. Studies primarily focusing on optimism and pain can be supposed to more accurately measure the two variables of interest. In experimental and clinical-longitudinal designs, confounding variables can be better controlled by context manipulation or recording temporal relationships.

The higher percentage of beneficial associations with increasing age of participants may be explained by a model proposed by Jylhä and colleagues.[102] The authors assume that self-rated health results from an

evaluation process, incorporating both physical health factors and additional factors such as chronological age or health expectations. Furthermore, according to the model, the relative importance of these evaluation criteria changes with age. Self-rated health in older people could reflect to a higher degree psychological adaptation to decreasing health than in younger people.[103] Similar processes might be at work in pain reports. In higher age, the relative importance of psychological processes such as appraisal or social comparison (for example, "It is normal to have pain at this age," "Given my high age, my pain is relatively low," etc.), which are in turn influenced by optimism, could become bigger compared to that of actual physical symptoms in predicting pain reports. These assumptions gain great plausibility because very similar phenomena have been repeatedly found for the prediction of self-rated health.[17–19]

Sixty-five of the 69 studies of this review were published after 2000, i.e. within a relatively short time span. Therefore, we cannot rule out that the age effect we found is in fact a cohort effect; that is, not caused by the age of participants, but by differences between earlier and later-born cohorts, for example as regards lifestyle, environmental conditions, values, or health/disease definitions.[17] Apart from that, the age effect we found could, as far as clinical studies are concerned, simply result from either a different pain duration or from different clinical conditions represented in the respective age groups: in our analysis, significant relations were most likely found with post-operative pain (beneficial associations in 80% of the respective studies) and rheumatoid diseases (75%, compared to 71% in cancer pain and 60% in musculoskeletal pain); all but two studies with an average age of above 60 years (k = 15 of 17) belong to either one of these two categories. Another possible explanation is that if individuals experience little pain from early on, this could in turn diminish their expectations of future harm and thus increase their optimism, which again would lead to even less pain experience. Over decades, these reciprocally intensifying effects could cumulate and stabilize the benefits of optimism at a high level. However, the fact that experimental studies revealed a higher percentage of significant beneficial associations even though their participants were younger than those in clinical studies (76.9% of laboratory studies had an age average younger than 30 years, compared to only 8% of clinical studies) casts some doubt on this assumption.

While previous research supports the moderating role of sex in that a stronger protective effect of optimism on health-related variables was found for men in general (e.g., in mortality, see Giltay et al.,[104] Peterson et al.[105]), only one of the 69 studies included in the present review[49] explicitly investigated sex differences of the optimism-pain relation: they detected a beneficial association for women and no association for men. Future studies should test for sex as a moderator variable.

Geers and colleagues[93] proposed the explanation that optimists are not generally less reactive to pain stimuli, which indeed could be highly dysfunctional in certain situations when detecting and monitoring pain is crucial. They assumed that instead optimists are more flexible in coping with pain than pessimists: they might be generally inclined to focus their attention on the positive aspects of a situation. Whenever it becomes apparent that certain stimuli (e.g., pain cues) are of relevance for their well-being and require their action, however, they could switch to an "approach mode" of problem-focused coping and face the pain, as described in Garofalo's[8] model for chronic pain.

It is thus conceivable that two different mechanisms are at work in experimental vs. clinical studies: healthy optimists who are confronted with an experimental pain induction are aware that the noxious stimuli are not harmful and will be over soon. It is likely that they therefore divert their attention from these negative features of the situation and subsequently report less pain. Corroborating this assumption, Peters and associates[106] found in an eye-tracker study that optimists tended to turn away from angry faces and gazed longer at joyful faces. Facing a serious threat to their well-being, on the contrary, such as an operation or cancer, the same optimists *focus* on pain and its context instead of withdrawing from it. They take steps to tackle the problem (cf. Luo et al.[107] for a study on optimism and skin cancer information) in the sense of the approach-style coping as described.[9] Unlike pessimists they still expect there are things they can do to improve their condition.

However, this problem-focused coping, based on the optimistic expectations that by trying hard pain will decrease, might not be unconditionally functional in people confronted with a *chronic* or malignant illness that holds little or no improvement over the years. When there is not much one can do about one's condition, strategies like acceptance and distraction are more suitable to maintain a high quality of life.[108] Indeed, in another study by Saariaho and associates[71] optimism was associated with active coping, which in turn had positive effects on chronic pain,

impairment and functioning. Active coping is conceptually different from the previously mentioned approach or problem-focused coping in that it does not aim at eliminating the problem (in this case, the pain or pain-related illness) but instead—much like acceptance strategies—aims at staying active and maintaining activities and well-being *despite* the pain. Furthermore, optimists have been reported to have the highly adaptive flexibility to switch to emotion-focused coping (including acceptance, seeking emotional support or positive reinterpretation) as soon as it becomes clear that the situation cannot be changed.[13] Thus, in chronic pain conditions, optimism may not be helpful anymore to lower pain, but it can still be of benefit for functioning and well-being.

Limitations

There are some limitations as to the generalizability of our conclusions and thus to the informative value of this review.

As mentioned, comorbidity and pain medication—two factors that strongly influence pain experience—have not been sufficiently documented and accounted for in a large part of the studies on patients. If they differ between optimists and pessimists, results could be distorted.

Besides, despite the high percentage of beneficial associations, one must consider that within the same study, the significance of these associations often tended to disappear as soon as more complex statistical models such as multivariate or hierarchical linear regression analyses were computed. This might partly be due to the reduced statistical power of complex models integrating several different variables. It is also conceivable, however, that optimism accounts for less incremental variance as soon as correlated variables are added to the model, i.e., there is no significant unique contribution of optimism in predicting pain. While there is evidence that the association of optimism with pain is independent of affect[39] and social desirability,[93] several other factors are possibly correlated with optimism. In some studies,[50,52,83] optimism reached significance when entered alone or early in the model, but did not explain significant additional variance as soon as other variables (e.g., control and benefit appraisals, self-efficacy, social support) were entered simultaneously or even before. It remains unclear whether any of these variables are mediators of the optimism-pain relation, i.e., whether optimism works through these mechanisms, or only moderators. In our descriptive analysis, we could not account for these possibilities and each result was weighted equally, independent of the statistical approach which was employed.

One must also take into account that our descriptive analysis was based on the percentage of significant effects. As we do not have detailed information on the power and robustness of the statistical tests employed in most studies, it is likely that both alpha and beta errors are contained in our sample of studies. We therefore recommend to especially consider effect sizes in future quantitative reviews.

Similarly, the percentage of significant associations between optimism and pain might be over-estimated if—due to publication bias—non-significant results were less likely to be published.

Even if optimism is measured at an earlier time than the pain experience (e.g., pre-operatively), and even in studies with adequate control groups, one cannot be entirely sure about the causality of the optimism-pain relation: it is also conceivable that a general preparedness for experiencing and coping with pain—be it due to biological or psychological predispositions or due to a sufficient "immunization" by gradual exposure and subsequent adaptation to pain in the past—has, over the years, resulted in a high level of dispositional optimism, which in turn will dampen future pain experiences. Thus, a reversed causality from little pain to high optimism cannot be ruled out. In consequence, lower levels of optimism in clinical pain cohorts[8,109] could either arise from the fact that less optimistic individuals are more likely to develop pain or from the tendency of patients' optimism to be dampened as a result of their increased pain vulnerability, existing already before the development of the clinical pain condition. Only some studies preclude this latter possibility by controlling for baseline symptoms or, as far as experimental designs are concerned, by manipulating optimism. Lastly, there could be third variables which substantially influence both pain and optimism reports, as for example response biases like a tendency towards positive statements. In consequence, we cannot derive definitive conclusions regarding causality from this review. The findings should cautiously be interpreted in terms of correlation.

While the focus of this review was on pain *experience*, one must keep in mind that especially in chronic pain this is not the only relevant pain outcome factor. Even when optimism does not positively affect pain intensity in itself, optimists could still benefit in other respects, as for example in adjustment to pain,[110] mood or goal-directed efforts.[111]

Given the heterogeneity of the retrieved studies in terms of design and measures (especially pain measures[112]), it was not possible to perform quantitative analyses including all of them. The present work may, however, be useful as a basis for future meta-analytic evaluations as it provides an overview of the variety of approaches and variables, which might be used to derive and answer more specific research questions.

Lastly, while we were obliged to focus on those moderating variables for which sufficient data were provided, it would be interesting to examine the role of further demographic and clinical variables such as, for example, ethnic background or pain duration, as soon as a critical number of studies will have become available.

The review provides suggestions for plausible mechanisms of the optimism-pain relation and likely moderating variables. These require explicit testing in future studies.

The manipulation of optimism—by means of future thinking exercises or semantic priming as, for example, in Fosnaugh and colleagues[21]—is a chance to explain causality and to develop clinical interventions. So far, the *Best-Possible-Self*-technique seems to be the only one to have been applied in the pain context.

Although in some subdomains studies are still missing (e.g., clinical studies applying an optimism manipulation), given the retrieved material and the number of studies with sufficiently homogenous outcome measures, we propose that the time is ripe for a meta-analysis. It seems reasonable that if a significant association of optimism with pain exists, this association is more likely to be detected in studies with high study/publication quality, which is why future research should be especially concerned with the mentioned quality criteria.

Furthermore, while our review was necessarily limited on pain *experience* in the narrow sense, we recommend enlarging future research to the previously mentioned other pain-related outcomes such as cognitive or emotional adjustment to pain or functional disability. These might reveal differential relations with optimism and thus provide further interesting insights into the optimism-pain research.

As shown in this review, optimism might be a powerful resilience factor against pain. Therefore, enhancing optimism could help in reducing acute pain experience as well as in preventing the transition to chronic pain. A recent meta-analysis[113] indicates that optimism can indeed be increased by psychological interventions in both clinical and healthy samples. Effect sizes were bigger when applying the BPS compared to other optimism interventions (for example cognitive-behavioral techniques) and when interventions were provided in person instead of online. While therapeutic short-term effects have been shown to be very likely, evidence for long-term effects is still scarce. Therefore, clinical research should focus on how to preserve and stabilize the short-term optimism effect for longer action. Meevissen and researchers[114] recently succeeded in creating longer-term changes in optimism in healthy individuals through an intensive optimism-fostering intervention. Another three studies[115–117] that trained optimism by combining the previously mentioned *Best-Possible-Self* imagery and writing technique with other positive psychology-exercises, found increased optimism for up to six months and promising results on well-being in chronic pain patients. This gives reason to hope that similar interventions may in future be used as part of the treatment of pain, possibly selectively in individuals "at risk", i.e., low in dispositional optimism.

Conclusions

The present analysis gives reason for assuming a beneficial association of optimism with pain experience. Studies with a presumed higher validity provided a higher percentage of beneficial associations. Significant associations between optimism and pain were more frequently found in older participants. Further research is needed to illuminate causal relations and to suggest evidence-based clinical applications of optimism-fostering interventions.

Notes

1. In order to avoid confusions of the term "positive result" which could be interpreted as either a positive correlation between optimism and pain or as a protective association (i.e., a negative correlation) between optimism and pain, the term "beneficial association of optimism with pain" (referring to a negative statistical correlation) will be used throughout the text.
2. In the following, numbers of studies are referred to by the *k* common in meta-analyses while numbers of persons are designated by *n*.

Disclosure statement

The authors declare that they have no conflict of interest.

Funding

This study was funded by Evangelisches Studienwerk Villigst.

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