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Top-Down or Bottom-Up? The Reciprocal Longitudinal Relationship Between Athlete's Domain-General Gratitude and Sport-Specific Gratitude: A Latent Difference Score Analysis

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Abstract
For athletes, gratitude has received substantial attention because it promotes their optimal functioning both in the sport domain specifically and in everyday life generally. The literature has, however, been equivocal as to whether it is domain-general gratitude—from the top-down perspective—or domain-specific gratitude—from the bottom-up perspective—that comes first and directs the other. Clarifying the relationship is important for designing more precise interventions. In this regard, we conducted a three-year, six-wave prospective study for youth athletes to examine the dynamic relationship between domain-general and sport-specific gratitude. Our latent difference score analysis indicated that a reciprocal model between the two levels of gratitude was superior to other, nonreciprocal models, suggesting that athletes who had higher domain-general gratitude would increase in sport-specific gratitude, which in turn contributed to increased domain-general gratitude across the six time points over the three-year period. Our study contributes to gratitude theories by uncovering the potential directional relationship for various levels of gratitude.

Keywords Prosocial motivation · Well-being · Athlete · Health

Athletes' mental wellness received worldwide attention after the defending gymnastics gold medalist Simone Biles abruptly withdrew from the 2020 Tokyo Olympics when she was already on the mat. She cited the potentially stress-induced and surely career-killing inability of spatial orientation in the air (i.e., the twisty) for her difficult decision. Another similar – and similarly shocking – event occurred when Naomi Osaka, a Grand Slam champion, openly admitted to suffering from major depression due to the chronic stress she and others commonly experience as professional

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athletes. These examples make it clear that glories in sports come with a price: stress that threatens not only athletes' mental and physical health but sometimes their lives. Investigating psychological protective factors against sports stress and the factors' potential derivative interventions are thus of high importance for professional athletes. Indeed, a well-balanced state of mind and body helps with not only well-being off the field but also optimal performance in front of crowds (Chen & Hsu, 2022; Moesch et al., 2018).

Contributing to the investigation, we hold that gratitude – one's tendency to recognize and respond with grateful emotions to other people's benevolence in one's positive experiences and outcomes (McCullough et al., 2002, p. 112) – fits well with the conceptual map of protective and risk factors from the literature (Kuettel & Larsen, 2020). Since early 2000, gratitude has demonstrated its benefits for people's adaptation, social relationships, physical health, and overall well-being. For example, Kashdan et al. (2006) found that gratitude predicts daily positive affect and self-esteem in Vietnam war veterans with posttraumatic stress disorder. In sports, gratitude was shown to be positively related to athletes' perceived social support and negatively related to experiencing burnout (Gabana et al., 2017). Finally, many reviews have suggested theoretical adaptive effects of gratitude for individuals of different stripes (e.g., Chen and Hsu, 2020; Cousin et al., 2021; Jans-Beken et al., 2020; Wood et al., 2010).

Nonetheless, emerging evidence indicates that the effectiveness of gratitude may vary across specific life domains, including but unlikely to be limited to work (when feeling grateful for coworkers' help; Cain et al., 2019), religion (grateful for gods' blessings; Krause, 2006; Krause et al., 2012), and sports (grateful for coaches' instructions; Chen and Chang, 2017; Howells & Fitzallen, 2020). For us, this implies that gratitude is a multidimensional, hierarchical construct. Borrowing from the top-down versus-bottom-up theory of subjective well-being (Headey et al., 1991), we theorize that there may be two levels of gratitude, as in the case of well-being. In particular, domain-general gratitude is the higher, more stable component; it generally affects individuals' appraisal tendencies regarding grateful feelings across life domains. In contrast, domain-specific gratitude is the lower, more flexible component of gratitude; it offers a contextual perspective and the related bottom-up effects on the development of domain-general gratitude.

Taking both the top-down and bottom-up processes into consideration may help complete the picture of individuals' optimal functioning because one may now ask: Do generally grateful persons who lead their lives in a top-down manner become more grateful in specific domains of life? Alternatively, do people who follow a bottom-up process become grateful in general later because of having been grateful in specific life domains? We believe that determining the direction of this relationship between the two levels of gratitude has both theoretical and practical significance. For theories, the top-down process would indicate that domain-general gratitude affects domain-specific gratitude, whereas the bottom-up process would suggest an effect in the opposite direction. Given that contradictory perspectives on the direction have never been investigated, the current study provides novel evidence. The investigation would then elucidated how personalities such as that of gratitude can be structured

in a hierarchical fashion. For practice, the investigation can help guide the design of interventions for athletes' and the general public's mental and physical health.

Accordingly, in the present research, we investigated the relationship between domain-general and domain-specific gratitude in terms of their adaptive effects for athletes. A three-year, six-wave prospective study was conducted with youth athletes. We focused on youth athletes because they are in the critical transitional stage of life in terms of their overall development (Arnett, 1999). Below, we elaborate on the literature and our hypothesis in the investigation.

Gratitude in Various Life Domains

Research on gratitude has flourished over the past two decades since McCullough et al. (2002) conceptualized and operationalized gratitude as an affective trait. Those with the trait, or simply grateful people, have a worldview that allows them to judge things in life as gifts and prevents them from taking the benefits for granted (McCullough et al., 2001). Not surprisingly, gratitude is found to enhance individuals' well-being by enabling them to accumulate more intrapersonal and interpersonal resources across life domains (Emmons & Mishra, 2010). In social network analysis, gratitude is further reported to generate upstream reciprocity and prompt relational resources to flow from the original beneficiary to third parties unrelated to the original benefactor, leading to a strengthened overall structure of organizations (Chang et al., 2012).

Beyond domain-general gratitude, researchers have begun to introduce gratitude into specific life domains to explain individuals' thoughts and actions in these contexts more precisely (e.g., Cain et al., 2019; Chen and Chang, 2017; Krause et al., 2017). For example, individuals might not have perfectionistic strivings and perfectionistic concerns in daily life; however, they might exhibit perfectionism in specific domains such as sports (Gaudreau & Thompson, 2010; Terry-Short et al., 1995). In this regard, distinguishing the dispositional tendency in specific domains from that in the general domain becomes important in providing a complete understanding of how a person acts in the general and specific life domains.

When people carefully consider domain-general gratitude, concrete objectives are not identified, and it is said that they are grateful for life as a whole. On the other hand, domain-specific gratitude usually has clear targets. Following this logic, research has begun to investigate gratitude in specific domains, such as the workplace, religious events, and sports. Cain et al. (2019) asked employers to indicate how grateful they were for their supervisors, coworkers, and salaries. The study consistently indicated that workplace gratitude significantly predicts work-related outcomes after controlling for general gratitude. Similarly, in a cross-cultural study, athletes who were grateful for their coaches and teammates still experienced higher team satisfaction and lower athlete burnout when general gratitude was controlled for. Meanwhile, general gratitude remains a more sensitive predictor of life satisfaction, vitality, and self-esteem (Chen & Chang, 2017). These seemingly conflicting findings suggest a multidimensional and hierarchical structure of gratitude that needs to be unpacked and explained.

The Reciprocal Relationship Between Domain-General Gratitude and Specific Gratitude

Having reviewed the possibility that, phenomenologically, gratitude can appear to be either a top-down or a bottom-up process, wherein domain-general gratitude either influences (i.e., top-down) or is influenced by (i.e., bottom-up) domain-specific gratitude, two more questions in this line of reasoning concern, first, *which* of the two processes between the two levels of gratitude actually exists and, second, *how* such a process comes about. For the former, domain-general and domain-specific gratitude may exhibit unidirectional, top-down or bottom-up causality, with one being the cause and the other being the effect. Alternatively, the two may be in a bidirectional, reciprocal causal loop, with both affecting the other. Indeed, it might be worth noting that even though domain-general and domain-specific gratitude are conceptually distinct, making it tempting for investigators to assume only one causal precedence between the two, reciprocal construction of the domain-general and domain-specific aspects of the same construct has been documented for several constructs in the literature (e.g., self-esteem; Rentzsch and Schröder-Abé, 2022), among which some are close concomitants of gratitude (e.g., life satisfaction; Chen et al., 2018). Reciprocal relationships are empirically possible.

Regarding how – we would argue in the present work – the top-down and bottom-up processes of gratitude are possible at the same time, there are theoretical reasons to believe that domain-general and domain-specific gratitude cause one another. As mentioned above, gratitude is a multidimensional construct with a situational experiential component – or feeling grateful in the moment – and a dispositional attitudinal component – or, for instance, the belief that "it's important to appreciate each day that you are alive" (Watkins et al., 2003). This modal distinction between domain-general and domain-specific gratitude highlights the similarity of the issue at hand to the classic phenomenon of a self-fulfilling prophecy (Merton, 1948), in which individuals with existing, trait-like, domain-general negative expectations toward social others would be guided by confirmation bias (Claire & Fiske, 1998) to find faults and notice unpleasurable exchanges from a new social partner to interact, exhibiting a causal effect of overall dispositional attitude *on* concrete situational experiences. After this direction of causal relationship is experienced a few times, the focal actor will normally retrospectively conclude that the relationship produced unwanted memories too often and that the social partner makes an overall bad companion, with the acting protagonist's attitude influenced *by* these relevant, domain-specific past experiences. Together, the two causalities may form a loop, reinforcing each other over time.

Supporting that a structural parallel exists between self-fulfilling prophecy and gratitude, theorists have approached either, if not both, dispositional grateful attitude as the primer of grateful feelings in a top-down fashion *or* situational grateful experiences as the building blocks of a grateful person(ality) in a bottom-up fashion. For the former, it has been found that individuals' overall grateful personalities, rather than domain-specific gratitude, forecast individuals' day-to-day feelings of gratitude, presumably across various domains and content-concrete life events (McCullough et al., 2004). Shedding light on *how* this top-down process comes about, it has been shown that people with a domain-general grateful personality tend to interpret every-

day encounters from an appreciative perspective (Wood, Maltby, Stewart, & Joseph, 2008a; Wood, Maltby, Stewart, Linley et al., 2008b). Although appreciation and thankfulness are not limited to a single life domain, they by definition are realized in concrete and specific life domains, creating domain-specific effects. In other words, as in the case of self-fulfilling prophecy, grateful persons "stereotype" (in a positive way, different from that in a self-fulfilling prophecy) the world before interacting with it and use that general stereotype to confirm (with a somewhat positive bias) what they already believe in specific interactions.

On the other hand, previous studies on gratitude interventions have alternatively shown that a general rather than domain-specific gratitude disposition can be trained from, say, counting daily blessings in specific life domains, making the latter a cause of the former. For instance, it has been documented that, compared to a control curriculum, a two-week gratitude curriculum for young students in which they learn to appraise specific daily exemplars of receiving favors from a positive, grateful light increases their feelings of gratitude in real life, that is, toward real-life others who are different from those in the learning material (Froh et al., 2014). Simply put, gratitude learned in one (imaginary) life domain "leaks out" and generates gratitude broadly in other (real) life domains. The former is the building block of the latter. Moreover, a meta-analysis on gratitude interventions ranging from gratitude journaling, gratitude letters and visits, counting blessings, grateful mental imagery, and gratitude visualization (e.g., drawing) finds that gratitude intervention, across types, has a decent $d=0.25$ effect on increasing grateful disposition (Dickens, 2017). That is, although the effect is not particularly large, rehearsing domain specific, content-concrete instantiations of gratitude contributes to the formation of one's overall, domain-general personality of gratitude.

Finally, emotion theorists have proposed and supported that all emotions, thus gratitude included, are constructed through "Bayesian updating" in the brain (Barrett, 2016). In particular, the brains of individuals are constantly predicting the feelings they should have in the next moment based on their existing knowledge of the world. For example, heading to a competition, athletes may unconsciously anticipate that various emotions – most likely anxiety over losing and joy over winning – will be induced by various opponents or accidents encountered at the event. Such an attitudinal set of predictions serves as the Bayesian prior in the updating process, predetermining the chance that one experiences various emotions. In other words, prior and, therefore, domain-general knowledge summarized from past experiences and brought into the present sets causal limits and affects actual experiences to occur in a top-down format.

Nonetheless, in the second step of the updating, the Bayesian prior is filtered and pruned by incoming sensations. For instance, if some athletes cannot stand humidity but hear news that the competition day will be humid, then this new information may tune down the chance of experiencing joy and tune up that of experiencing anxiety. Step by step, if, unfortunately, the prior for anxiety keeps rising and passes the threshold, one will experience anxiety, say, when being on the field and watching dark clouds in the sky. If this occurs, the process that finalizes in the Bayesian posterior of anxiety in the specific life event will be organized – updated – into one's overall expectation of anxiety, subsequently being used as the Bayesian prior for

the future. As a result, domain-specific experiences contribute to people's domain-general emotional schemes by creating and steering future predictions of the world in a bottom-up format. Together, the theory of constructed emotions suggests that not only are both domain-general and domain-specific emotion schemes, including those of gratitude, plausible causes of the other, they both are causes of the other in a reciprocal construction.

To examine the possible relationships between domain-general and domain-specific gratitude, a three-year six-wave prospective investigation with a youth athlete population was conducted. We focused on adolescent athletes because they are in a critical stage of life in terms of their overall development (Arnett, 1999). Ruling out the possible directions would help researchers design more comprehensive interventions to enhance their mental health. Based on the review above, the current study predicts a reciprocal relationship. However, given that this issue has not been previously explored, we also expect that a different pattern might emerge that contributes new knowledge to the literature.

Method

Participants and Procedures

Five hundred and two athletes from 17 high schools initially participated in this study. The number of athletes changed over the three-year study period due to attrition (see Table 1). The athletes entered this study when they were in their freshman years. We obtained permission from the Institutional Review Board and the high schools to perform the research with the athletes in each class during their break time. The athletes were invited to join the study and did so voluntarily. As our participants were initially under 18 years old, we also received consent from their parents before conducting the survey.

In the class, the athletes read and signed the informed consent form, which explained their rights as study participants. The study survey was administered by a research assistant in classrooms without the coach present. The students returned their questionnaires directly to the research assistant. As such, only the research team had access to the student athletes' responses. The students were asked to provide their student IDs, which were used to match their data. As the research team did not have the students' identification information, such as their names matching their student IDs, there is no way for the research team to link responses to specific students. This procedure thus protects response confidentiality and anonymity.

The data collection period was from September 2019 to May 2022. Each wave was conducted approximately 5 months apart. The time intervals were chosen to accommodate the athletes' schedules to avoid their competition seasons. The mean age in the first wave was 15.29 years ($SD = 0.48$), and the average number of years of experience with their specialized sport was 4.24 ($SD = 2.49$). The athletes participated in 28 sport specialties. In total, there was 1 cheerleader, 2 modern pentathletes, 3 wooden ball athletes, 3 Western-style rowing athletes, 3 martial artists, 3 soft tennis players, 7 kendo athletes, 8 tug of war athletes, 8 pool athletes, 8 weightlifters, 9

wrestlers, 10 fencers, 11 handball athletes, 11 football athletes, 15 swimmers, 17 volleyball players, 20 table tennis players, 22 shooting athletes, 22 baseball players, 26 archers, 26 softball players, 27 Korfball athletes, 27 rugby athletes, 37 judo athletes, 43 basketball players, 65 track and field athletes, and 68 taekwondo athletes.

Measurement

Domain-general Gratitude

The Gratitude Questionnaire (GQ; McCullough et al., 2002) was used to assess the individuals' dispositional gratitude. The original GQ has six items, and its reliability and validity have been established. In the current study, the GQ-Taiwan version (GQ-T) was used to assess dispositional gratitude (Chen et al., 2009). Only five items of the GQ-T were used because one of the items (Long amounts of time can go by before I feel grateful something or someone)[1] was dropped due to nonsignificant factor loading. The GQ-T is positively related to happiness, optimism, agreeableness, and extraversion but negatively correlated with neuroticism, which supports its validity in this study. In addition, the GQ-T has been widely used in Chinese-speaking (Chen et al., 2012; Loo et al., 2014; Zeng et al., 2017) and athlete samples (Chen & Chang, 2017; Chen & Wu, 2016). The response scale for all items ranged from 1 (*strongly disagree*) to 7 (*strongly agree*). Cronbach's alphas for this measure for wave 1 to wave 6 were 0.74, 0.75, 0.70, 0.71, 0.72, and 0.74, respectively.

Domain-Specific Gratitude

The six-item Gratitude Questionnaire-Sport (GQ-S; Chen and Kee, 2008) was used in the current study. Derived from a general gratitude scale (McCullough et al., 2002), the GQ-S is used to assess athletes' gratitude in the context of sports. This measure contains a single factor, and the scale's reliability and incremental validity are supported by previous research. Specifically, Chen and Chang (2017) conducted two independent studies and demonstrated that the GQ-S accounted for increased explained variance in team satisfaction and burnout among athletes after controlling for domain-general gratitude. A sample item is "I have so much in my entire sport experience or endeavor to be thankful for." The response scale for all items ranged from 1 (*strongly disagree*) to 7 (*strongly agree*). Cronbach's alphas for this measure for wave 1 to wave 6 were 0.72, 0.71, 0.70, 0.71, 0.72, and 0.72, respectively.

[1] Since researchers consistently demonstrated that this item in the GQ might not be valid (poor model fit and low reliability) across cultures and populations (e.g., Froh et al., 2011; Ling et al., 2021; Magallares et al. 2018; Zeng et al., 2017), which provided evidence supporting the use of five items, the GQ-T was appropriate.

Analysis Strategy

First, we examined the longitudinal invariance of the GQ-T and GQ-S to ensure that the change phenomena captured in this study were related to the changes in constructs (Golembiewski et al., 1976). There are several levels of longitudinal invariance (Chan, 1998; Meredith, 1993; Vandenberg & Lance, 2000). The first level is configural invariance (Model A). It requires the same item to be associated with the same factor at each measurement occasion. After establishing configural invariance, the second level is weak invariance (Model B). It includes factor loadings that are constrained to be equal across time points to test the invariance of the factor loadings. Based on the weak invariance model, the third level is strong invariance (Model C). This indicates that intercepts are constrained to be equal across time points. In addition, for tests of longitudinal invariance, in addition to the chi-square differences between pairs of nested invariance models (Chan, 1998), we also adopted the difference in CFI, which is increasingly recommended in invariance testing (ΔCFI; values $\leqq 0.01$ indicate invariant; Cheung and Rensvold, 2002) because the chi-square difference is sensitive to sample size. Therefore, measurement invariance was estimated using configural, weak, and strong invariance in the current study, allowing us to provide an unambiguous interpretation of change (Chan, 1998).

Second, because our goal was to understand whether athletes' GQ-S shapes their GQ-T reciprocally over time and vice versa, we used latent difference score modeling[2] (LDSM; McArdle, 2009) for the data analysis. LDSM focuses on within-individual changes in variables between adjacent time points and individual differences in such within-individual changes, enabling us to examine the development and changes in GQ-T and GQ-S for each individual (Grimm et al., 2012; Selig & Preacher, 2009). For example, an LDSM approach creates latent difference scores between variables measured at adjacent time points and then examines how variables measured at previous time points (e.g., GQ-T and GQ-S at Time 1) shape within-individual changes over two adjacent time points (e.g., changes in GQ-T and GQ-S from Time 2 to Time 3). An LDSM approach is more appropriate than a cross-lagged modeling (CLM) approach for our research purpose because CLM does not consider changes occurring at the individual level or individual differences around within-individual change. Although a latent growth model also taps into within-individual changes over

[2] The key advancement in our study is the implementation of latent difference score modeling (LDSM), a method that has distinct strengths and inherent limitations. LDSM excels in capturing individual variations over time, enhancing our understanding of evolving patterns. By utilizing difference scores, LDSM effectively reduces noise from measurement errors or individual discrepancies, improving the accuracy of our findings. Moreover, LDSM allows for the interpretation of observed changes as the result of underlying latent factors, providing profound insights into mechanisms. However, it is important to acknowledge certain limitations. The'regression to the mean' effect associated with LDSM can lead to overestimation or underestimation, as observed values tend to converge toward the mean after extreme instances. Additionally, LDSM is sensitive to the choice of initial values, introducing potential variability in the results and increasing uncertainty. Last, the method relies on assumptions such as linear change and normal distribution, which may not always hold in practical applications. Therefore, careful interpretation of the results is necessary. In summary, while LDSM effectively captures individual variations and reduces noise, researchers must be cautious of its sensitivity to initial values and the potential for regression to the mean. This awareness ensures a comprehensive evaluation of the study's findings and their implications.

time, it is used to model larger-scale change trajectories over the entire study period, more or less ignoring individual period. In contrast, LDSM focuses on step-by-step, smaller-scale changes from one time point to the next and, as such, is more suitable for studying the interweaving of multiple constructs, e.g., of domain-general and domain-specific gratitude.

Third, all models were estimated using Mplus (Muthen & Muthen, 2010). Given the nonnormality of the data and missing data, we used maximum likelihood estimation to produce covariance matrices with robust standard errors (the MLR estimator in Mplus). This estimation method yields robust calculation against the nonnormality of data and can also handle missing data in calculations. Moreover, because these data were collected from different teams, potential bias may have been introduced by the shared variance between athletes on the same team. To address the nonindependence between repeated-measure data, we employed the design-based modeling approach proposed by Wu and Kwok (2012, p. 17) that "takes the multilevel data or dependency into account by adjusting for parameter estimate standard errors based on the sampling design." Specifically, this was done by the TYPE = COMPLEX command in Mplus (Muthén & Satorra, 1995; Wu & Kwok, 2012) that, in our case, accounted for athletes' data clustered and nested in teams.

Finally, all analyses in the current study were estimated using full-information maximum likelihood (FIML) estimation. FIML is regarded as more reasonable for dealing with missing data (Graham, 2009; Schafer & Graham, 2002). Therefore, the FIML estimate with robust standard error correction (i.e., MLR estimator) in Mplus was used to obtain a consistent standard error estimate to produce the correct statistical inference for the parameter estimate (Schlomer et al., 2010, p. 189). To assess the overall model goodness-of-fit to the data, we used four fit indices: comparative fit index (CFI), Tucker–Lewis index (TLI) (CFI & TLI values > 0.90 indicate acceptable fit, > 0.95 indicate excellent fit), root mean square error of approximation (RMSEA) with 90% confidence intervals (RMSEA < 0.08 is acceptable, < 0.05 is excellent), and standardized root mean square residual (SRMR; < 0.10 is acceptable) as recommended by Hu and Bentler (1999). Given the sensitivity of the $\chi 2$ difference test with large samples (Meade et al., 2008), we prioritized the Akaike Information Criterion (AIC), the Bayesian Information Criterion (BIC), and its sample size adjusted version (ABIC) in comparing the competing models, where smaller values indicate a better fitting model (Vrieze, 2012). We also performed robust chi-square difference tests to compare nested models (Bryant & Satorra, 2012; Satorra & Bentler, 2001). Hence, in the current study, the rules that they proposed were used for reference.

Results

Descriptive Statistics and Longitudinal Invariance

Table 1 presents the means, standard deviations, reliability coefficients, and correlations of the variables, including the GQ-T and GQ-S mean scores across time points. Then, we tested the longitudinal invariance of the items for the GQ-T and GQ-S. Table 2 presents the results indicating the extent to which the invariance models fit

Table 1 Correlations among variables are based on pairwise deletion of missing data

	N	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11
1.GQ-T(t1)	502	6.02	0.98											
2.GQ-T(t2)	463	5.91	1.02	0.48										
3.GQ-T(t3)	442	5.94	1.09	0.51	0.47									
4.GQ-T(t4)	406	5.93	1.05	0.46	0.55	0.51								
5.GQ-T(t5)	430	5.84	1.17	0.36	0.44	0.42	0.48							
6.GQ-T(t6)	402	5.73	1.16	0.62	0.36	0.40	0.35	0.27						
7.GQ-S(t1)	502	5.81	0.94	0.50	0.38	0.39	0.47	0.28	0.54					
8.GQ-S(t2)	463	5.69	1.01	0.42	0.51	0.47	0.38	0.49	0.41	0.43				
9.GQ-S(t3)	442	5.69	1.06	0.55	0.42	0.58	0.44	0.42	0.35	0.33	0.37			
10.GQ-S(t4)	406	5.61	1.02	0.47	0.33	0.59	0.49	0.57	0.57	0.41	0.66	0.67		
11.GQ-S(t5)	430	5.59	1.12	0.39	0.41	0.45	0.53	0.55	0.37	0.40	0.62	0.51	0.39	
12.GQ-S(t6)	402	5.44	1.09	0.40	0.46	0.33	0.31	0.52	0.34	0.39	0.29	0.31	0.33	0.37

Note: Correlations greater than 0.15 are significant at $p < .05$; those greater than 0.19 are significant at $p < .01$; those greater than 0.25 are significant at $p < .001$

the data. First, the baseline models of GQ-T and GQ-S (Model A) were acceptable. The factor loadings were constrained to be equal across time points to test for weak invariance.

The weak invariance models for both GQ-T and GQ-S (Model B) were acceptable because of the satisfactory values of the fit indices. Both the SB-χ^2 difference test and the comparison of CFI between the configural invariance and weak invariance models were invariant (ΔSB-$\chi^2 = 12.01$, $p > .0.5$; ΔCFI = 0.00), supporting weak invariance. Second, equality of the intercepts across time points was imposed on the model to test for strong invariance. The strong invariance models for both GQ-T and GQ-S (Model C) were acceptable because of the satisfactory values of the fit indices. Both the SB-χ^2 difference test and the comparison of CFI between the weak invariance and strong invariance models were invariant (ΔSB-$\chi^2 = 43.12$, $p < .05$; ΔCFI = 0.00), supporting strong invariance.

Latent Difference Score Modeling

To test the effects across constructs over time, we selected variables at the previous time (e.g., Time 1) to predict latent change scores at two time intervals (e.g., from Time 1 to Time 2). We included correlations between constructs at Time 1 to acknowledge their cross-sectional relationship and correlations between latent difference scores of constructs in the same period to acknowledge associations between

Table 2 Model Fits for Measurement Models of GQ-T and GQ-S in Longitudinal Invariance

Model	SB-χ2	*df*	*p*	CFI	TLI	ΔSB-χ2	ΔCFI	RMSEA	SRMR
Measurement Models of GQ-T and GQ-S									
GQ-T (t1)	34.08	5	0.00	0.96	0.92			0.088(0.075; 0.119)	0.036
GQ-T (t2)	35.67	5	0.01	0.96	0.92			0.089(0.063; 0.120)	0.037
GQ-T (t3)	22.01	5	0.01	0.96	0.93			0.089(0.078; 0.113)	0.037
GQ-T (t4)	27.88	5	0.00	0.97	0.93			0.088(0.073; 0.120)	0.036
GQ-T (t5)	31.78	5	0.00	0.97	0.92			0.089(0.082; 0.123)	0.040
GQ-T (t6)	42.10	5	0.00	0.97	0.91			0.088(0.082; 0.119)	0.042
GQ-S (t1)	44.17	6	0.01	0.95	0.90			0.089(0.063; 0.120)	0.049
GQ-S (t2)	42.89	6	0.01	0.95	0.91			0.089(0.054; 0.132)	0.044
GQ-S (t3)	46.19	6	0.01	0.95	0.91			0.089(0.051; 0.123)	0.048
GQ-S (t4)	52.13	6	0.00	0.96	0.92			0.088(0.068; 0.119)	0.056
GQ-S (t5)	45.11	6	0.00	0.96	0.90			0.088(0.042; 0.118)	0.049
GQ-X (t6)	46.70	6	0.00	0.96	0.91			0.088(0.040; 0.121)	0.052
Models for Longitudinal Invariance									
Model A (baseline)	484.12	326	0.00	0.95	0.94			0.053(0.036; 0.071)	0.056
Model B (weak invariance)	496.13	340	0.00	0.95	0.94	12.01	0.00	0.052(0.030; 0.082)	0.060
Model C (strong invariance)	538.25	355	0.00	0.95	0.95	43.12*	0.00	0.063(0.042; 0.0109)	0.062

Table 3 Model-data fit indices and likelihood ratio tests for latent change score models for six-wave of three-year of domain-general gratitude and sport-specific gratitude

	Baseline model	Top-down model	Bottom-up model	Reciprocal model
SB-χ^2 (df)	485.59(328)	449.01(326)	426.73(326)	401.29(324)
p	<0.001	<0.001	<0.001	<0.001
RMSEA (90% CI)	0.046 (0.041-0.048)	0.048 (0.044-0.051)	0.050 (0.047-0.056)	0.045 (0.041-0.047)
CFI	0.97	0.97	0.98	0.98
TLI	0.96	0.97	0.97	0.98
AIC	184809.18	184799.37	184808.07	184772.57
BIC	184992.54	184996.92	185005.62	184984.23
ABIC	184910.90	184907.94	184916.64	185488.89

Note: Top-down model=Domain-general gratitude → Sport-specific gratitude; bottom-up model=Sport-specific gratitude → Domain-general gratitude

changes in constructs. The error terms of the indicators at T1 were allowed to covary with the error terms of the corresponding indicators at T2, T3, T4, T5 and T6. This model fit the data well (SB-χ2=435.81, *df*=269; CFI=0.96; TLI=0.95; RMSEA=0.037; SRMR=0.052).

Table 3 presents the fit indices and likelihood ratio tests for latent change score models for six waves over three years for domain-general gratitude and sport-specific gratitude. All four models exhibited excellent model-data fit, although the reciprocal effects model best fit the data, as it had the lowest AIC, BIC and ABIC values. The likelihood ratio test also supports the superiority of the reciprocal effects model (see Fig. 1) (top-down vs. reciprocal: ΔSB-χ2=47.72, Δdf=2, p<.05; bottom-up vs. reciprocal: ΔSB-χ2=25.44, Δdf=2, p<.05).

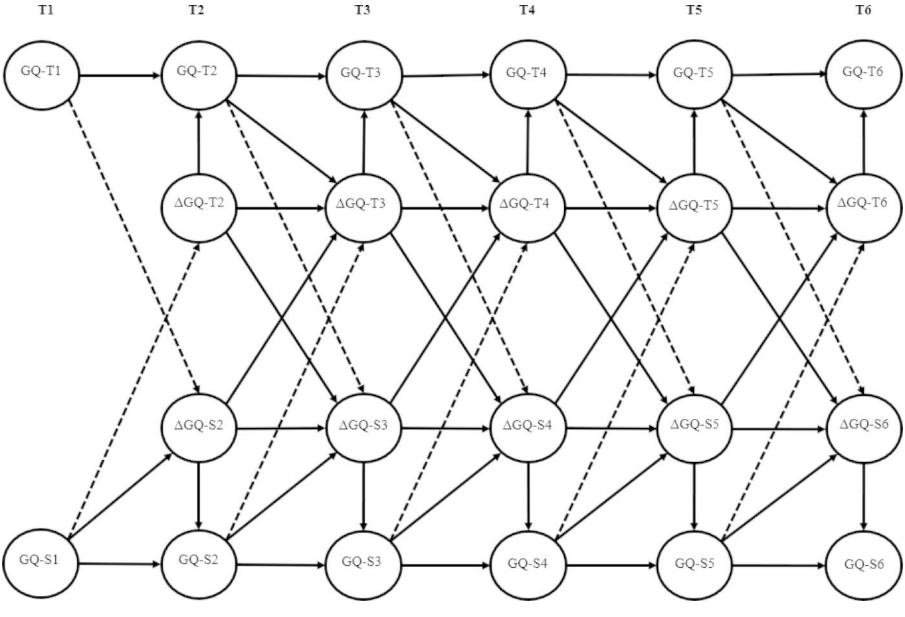

Fig. 1 The hypothesized model of current study

Table 4 Unstandardized parameter estimates of reciprocal latent difference score model

	B	SE	*p*
GQ-T slope (μ)	2.11	1.11	0.02
GQ-T intercept (μ)	3.03	0.32	0.01
GQ-S slope (μ)	1.72	0.59	0.02
GQ-S intercept (μ)	2.55	0.42	0.01
GQ-T slope (σ^2)	0.46	0.41	0.03
GQ-T intercept (σ^2)	3.16	1.82	0.02
GQ-S slope (σ^2)	0.16	0.06	0.04
GQ-S intercept (σ^2)	0.27	0.30	0.03
Correlations			
GQ-S slope ↔ GQ-S intercept	0.12	0.05	0.04
GQ-S slope ↔ GQ-T slope	0.22	0.05	0.03
GQ-S slope ↔ GQ-T intercept	0.11	0.31	0.04
GQ-S intercept ↔ GQ-T slope	0.18	0.20	0.03
GQ-S intercept ↔ GQ-T intercept	0.10	0.26	0.04
GQ-T slope ↔ GQ-T intercept	0.25	0.96	0.03
Proportional Effects			
GQ-T status →GQ-T change	0.21	0.24	0.04
GQ-S status →GQ-S change	0.44	0.32	0.01
Coupling Effects			
GQ-T status →GQ-S change	0.10	0.11	0.03
GQ-S status →GQ-T change	0.53	0.43	0.02
Change to Change Effects			
GQ-T change →GQ-S change	0.39	0.28	0.02
GQ-S change → GQ-T change	0.12	0.19	0.04

Note: B = unstandardized effect; SE = standard error; μ – mean; σ^2 = variance

An overview of the unstandardized parameter estimates of the reciprocal effects model is presented in Table 4. The findings demonstrated a positive linear change component for the GQ-S. That change component was proportional to prior status on the GQ-S and GQ-T, such that higher levels of the GQ-S and GQ-T at the previous measurement wave were associated with higher increases in GQ-S at subsequent waves. The GQ-T findings had both similarities with and differences from the GQ-S. Changes in GQ-S predicted future GQ-T changes, such that upward changes in GQ-S upregulated future GQ-T. The change in GQ-T was not proportional to prior GQ-T status but was contingent upon previous GQ-S levels. Specifically, the higher the GQ-S level reported in the previous measurement wave, the greater the increase in GQ-T in the subsequent wave.

Discussion

In this study, we conducted a longitudinal study to clarify the possible relationship between domain-general and sport-specific gratitude. The results of latent difference score modeling indicate that the reciprocal model is superior, suggesting that athletes who have higher domain-general gratitude would increase sport-specific gratitude over time, which, in turn, would contribute to a growth in their domain-general gratitude. As such, the current study makes two important contributions to the gratitude

literature. First, to our knowledge, our study is the first to demonstrate that there exist two levels of gratitude and to further clarify the two's intrapersonal cochanges across time. This finding responds to the debate as to whether the top-down or bottom-up process comes first. Second, interventions that aim to increase athletes' well-being may be designed when referring to our results. It is suggested that both domain-general gratitude and sport-specific gratitude are potential targets of interventions.

Implications

For the theoretical contribution, the current study might be the first to unravel the puzzle about the longitudinal relationship between domain-general and domain-specific gratitude in the sports domain of life. The reciprocal relationship was supported by our empirical data suggesting that the two constructs were intertwined over time. Specifically, the unstandardized parameter of change-to-change effects indicated that the top-down process was stronger than the bottom-up process over time. It raised interesting issues partially corresponding to the analysis of the *scope* and *centrality* of an individual's life experiences (Bharadwaj & Wilkening, 1977). Here, the scope is the extent to which the experiences encompass different social others and activities; centrality is the degree to which the experiences are persistent in the forefront of the individual's consciousness (Cragin, 1983, p. 265). Therefore, if the scope is broad and the centrality is low, the top-down, domain-general gratitude would dominate, thus potentially operating mostly like a dispositional trait, consistent and comprehensive across different domains of one's life. In contrast, if the scope is narrow and the centrality is high, the bottom-up, domain-specific gratitude would turn on and take over. Take our current case focusing on sports. Such bottom-up causality means an effect chain most likely from athletes' social others, such as teammates, couches, and even opponents benefiting the athletes, to the athletes' domain-specific gratitude formed on the basis of beneficial encounters in the sports domain, and finally the athletes' domain-general gratitude evidenced and bolstered by sports-specific gratitude. Together, the process exists much like classical social learning, wherein young students' self-efficacy is affected by teachers' feedback on their performances and school-domain, social-interaction-based self-efficacy guides students' adult lives in various other domains (Bandura, 2001).

Moreover, it should be noted that there is little to no similar research showing a constant reciprocal relationship between a domain-general construct and its domain-specific counterpart, even though such a phenomenon is found for gratitude in the present study. In particular, Chen et al. (2018) used three waves of data to investigate the reciprocal relationship between athletes' overall life satisfaction and specific team satisfaction. Their results indicated a reciprocal relationship between T1 and T2, but a bottom-up only process was supported between T2 and T3. Likewise, Rentzsch and Schröder-Abé (2022) conducted a four-wave longitudinal study across six years to investigate the reciprocal relationship between global self-esteem and domain-specific self-esteem, providing evidence only of top-down effects. These pieces of indirect evidence should nonetheless not be a threat to our results. Instead, they beg the question as to the reciprocal relationship between domain-general and domain-specific *gratitude*, compared to the same pairs of other constructs, in other

life domains such as work and religion. Would the same pattern be supported as in our study? These unexplored domains are beyond the scope of the current results, yet further clarification is no doubt desired.

For the practical contribution, the found reciprocal relationship indicates that the change-to-change effects for the top-down effect (B = 0.39) are stronger than those for the bottom-up effect (B = 0.12) over time. Previous studies have shown that gratitude journals and gratitude letters promote changes in domain-general gratitude (Dickens, 2017). These simple practices can be integrated into athletes' daily training to promote their domain-general gratitude. For one, following our results, this enhanced domain-general gratitude may subsequently spill over to sport-specific gratitude, which has been shown to be critical for many aspects of athletes' wellbeing in their sports lives (Chen et al., 2021; Hsu et al., 2020). At the same time, interventions aimed at promoting sport-specific gratitude might have a relatively weak, yet not ignorable, promoting effect on domain-general gratitude. Here, the literature has indicated that gratitude is one of the most stable and strongest predicters of wellbeing in life (Cregg & Cheavens, 2021; Jans-Beken et al., 2020). A mutually reinforced structure of gratitude for athletes would hence not only contribute to their quality of life in the sports domain but also in life overall. Given the size of the effect, we suggest that these interventions aimed at promoting gratitude should first focus on general gratitude enhancement for athletes. However, given different circumstances, it may start from the sports domain as well.

However, as we would like to stress, we are not suggesting ignoring the importance of sport-specific gratitude in interventions, especially when considering athletes' well-being. Chen and Chang (2017) investigated the relationship between gratitude and athletes' well-being. They reported that domain-general gratitude is more closely related to the general well-being index (life satisfaction, vitality, and self-esteem) but not the sport-specific well-being index (athlete burnout and team satisfaction), even after controlling for sport-specific gratitude. On the other hand, sport-specific gratitude demonstrated incremental validity in predicting the sport-specific well-being index (athlete burnout and team satisfaction) when domain-general gratitude was partialed out, and this pattern was supported by their cross-cultural data (Taiwan vs. the US). In this regard, their study reminds researchers that if the goal is to promote the relationship between gratitude and well-being, domain characteristics should be included. For example, Salim and Wadey (2021) asked injured athletes to write and deliver a gratitude letter to someone who had done important things for them during their injury experience. The study's experimental group demonstrated higher scores for relating to others, a dimension of sport injury-related growth. Therefore, we conclude that designing both domain-general gratitude and sport-specific gratitude interventions may be equally important if we want to precisely promote athletes' well-being.

Limitations and Future Directions

There were limitations in this study. First, gratitude is a multidimensional and hierarchical construct, and we investigated only one domain-specific form of gratitude, that is, in sports. Hence, researchers should be cautious in future investigations when

generalizing the results to other domains of gratitude. Second, we did not explore the specificity of time points because the time intervals chosen in our study were limited by the athletes' training schedules and, as such, did not vary naturally as a research variable should. Indeed, we are aware that the time before and after the competitive season and the postponement of critical sport events (e.g., the Olympic Games) may be especially informative points for assessing changes in our targeted variables. However, it was our intention to investigate the changes in gratitude over a relatively long period rather than during these short-term events. In doing so, perhaps our results might adequately depict the natural change in gratitude in the real environment, at least in sports. Third, the present study was conducted in a Chinese culture, Taiwan. It is a strength, as there has not been much work examining the relationship between culture and gratitude in non-Western countries. Our findings therefore may add to a more balanced understanding of gratitude across the world, echoing the fields' call for a more culturally inclusive and, thus, truer picture of human wellbeing (Shek, 2014). Nonetheless, it should be emphasized that even though the study was conducted in an interesting culture, we did not investigate culture as a construct. Consequently, we feel it is important to point out this theoretical limitation of our research for future investigations while at the same time refraining from reading to much into the uncertain cultural uniqueness or similarity of the results.

Conclusion

In summary, our study was the first to investigate the relationship between domain-general gratitude and sport-specific gratitude. Our six-wave three-year longitudinal study with youth athletes uncovered the reciprocal directionality that inspires us to explore multidimensional and hierarchical constructs of gratitude in various life domains. Hopefully, as more research emerges, the pattern of domain-general gratitude and domain-specific gratitude becomes clearer.

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Data Availability Data can be required form the authors.

Declarations

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

Compliance of Ethical Standard Statement This study was approved by the National Taiwan University review board (201712ES027).

Informed Consent The athletes were instructed to read the information sheet, and signed an informed consent form before the survey. Therefore, their confidentiality and anonymity were ensured.

Permission to Reproduce Material from Other Sources No.

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