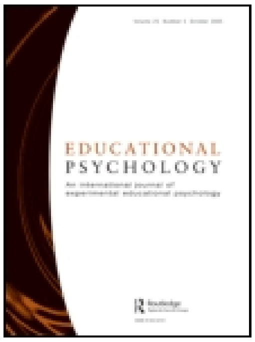

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Why students need to be prepared to cooperate: a cooperative nudge in statistics learning at university

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Despite the potential benefits of cooperative learning at university, its implementation is challenging. Here, we propose a theory-based 90-min intervention with 185 first-year psychology students in the challenging domain of statistics, consisting of an exercise phase and an individual learning post-test. We compared three conditions that manipulated the exercise phase: individual work, cooperative dyadic instructions (structuring three basic components of cooperative learning: positive goal interdependence, individual responsibility and promotive interactions) and cooperative dyadic interactions (the three basic components with an additional cooperative nudge, namely explaining why and how to cooperate in this task) in order to test whether a progressive increase in benefits occurs as the cooperative structure is reinforced. Results indicated a linear trend in individual post-test learning and competence perception, from individual work to cooperative instructions to cooperative interactions. Competence perception mediated the effect of experimental conditions on learning. The results highlight the benefits of the cooperative nudge.

Keywords: cooperative learning; cooperative skills; preparation for cooperation; competence perception; statistics learning

Cooperative learning proposes that students work together towards a common academic goal while learning from each other. It has been studied for decades and has benefited from different theoretical perspectives (see Slavin, 2011, for a review of theoretical approaches), from which widely used methods have been developed (see Sharan, 1999, for a review) and numerous studies have been performed to test its effects compared with more traditional methods. Indeed, several meta-analyses have emphasised its positive learning outcomes compared with individualistic or competitive settings (see Hattie, 2008, for a review of meta-analyses), from elementary school (e.g. Gillies, 2003) to university (e.g. Johnson & Johnson, 2002).

Cooperative learning could be a positive experience at university, but its benefits are not automatically granted as soon as group work is put into place: several obstacles might need to be overcome to boost the benefits of cooperative learning (Sharan, 2010) that make it necessary to prepare students to cooperate. Because students are not likely to cooperate spontaneously or efficiently, we argue that if we prepare them for cooperative learning – by explaining why and how to interact

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cooperatively in a specific academic task – they will feel more competent in the task, which should then increase their learning outcomes. More precisely, the aim of this intervention is to test whether additional elements in a cooperative structure would progressively favour cognitive and socio-cognitive outcomes. Because our approach is based on the enhancement of competence perceptions, it allows us to hypothesise that such positive gains may be obtained even with a short and simple intervention. This is shown in a particularly challenging domain for university students and teachers: statistics courses for psychology students.

Cooperative learning: a structured peer learning method

A subset of peer learning, namely cooperative learning, involves active helping and supporting among students in order to develop mutual knowledge and skills, but also requires structuring of positive interdependence (Topping, 2005). Cooperative learning is based on group work that is structured by teachers in order to maximise learners' social, motivational and cognitive outcomes (Johnson & Johnson, 2009; Slavin, 2011). Some common components define cooperative learning: teachers propose that students work together in small groups in order to accomplish a common educational goal, using a task that encourages positive goal interdependence, personal responsibility/individual accountability, and promotive interactions (Davidson, 1994; Sharan, 2010). Positive goal interdependence exists when group members perceive that they share a common goal and that the actions of each of them allow the achievement of this goal (Johnson & Johnson, 1989). In cooperative learning, teachers also make learners responsible and accountable for their own learning and for helping others to learn. Moreover, teachers encourage promotive peer interactions oriented towards social and academic support and help.

Cooperative learning allows the development of both academic and social skills, as well as social relationships (Johnson & Johnson, 1989; Roseth, Johnson, & Johnson, 2008; Tolmie et al., 2010). From a synthesis of different meta-analyses, Hattie (2008) showed that the effect size can be considered moderate to strong in the area of education. Research devoted to the comparison of cooperative learning with individualistic methods indicates that average learners working in cooperative groups achieve at about two-thirds of a standard deviation above learners working in an individualistic situation or within a competitive setting (e.g. Johnson & Johnson, 2005). This background predicts that a cooperative learning structure contributes to achievement increases compared to individual work.

Supporting cooperative learning

Cooperative learning seems to be a powerful tool for learning. Nevertheless, research also indicates that cooperative gains in cognitive outcomes, in comparison with the results of more traditional methods, appear in 63% of the comparisons in a study by Slavin (1983b) and in 53% of the comparisons in another by Johnson and Johnson (1989). This raises the question of which conditions are necessary for effectiveness in cooperative learning. Many researchers have reported that group work is not always effective (Blatchford, Baines, Rubie-Davies, Bassett, & Chowne, 2006; Blatchford, Kutnick, Baines, & Galton, 2003); important conditions include both the need to structure cooperative learning (Gillies, 2004, 2008; Webb, 2009) and to prepare students to cooperate (Blatchford et al., 2003; Johnson & Johnson, 2006; Tolmie et al., 2010; Webb, 2009) in order to promote constructive interactions.

Some group work programmes have developed a broad approach for classrooms by taking into account the nature of teacher involvement and ways of structuring the classroom environment (Baines, Rubie-Davies, & Blatchford, 2009; Blatchford et al., 2003, 2006). These programmes propose introducing tasks and lessons that are likely to favour group work and discussion, developing students' group work skills, taking care of classroom and group arrangements, and stressing the importance of teachers' involvement. Despite a number of positive results, this approach requires a very high level of involvement from teachers, which may be discouraging. We propose that a simpler and lighter intervention may have positive results, if it is based on instructions that focus students on learning and understanding, and if it establishes positive norms for cooperative work and constructive behaviours (Webb, Farivar, & Mastergeorge, 2002).

Different strategies have been suggested in order to develop peer constructive behaviours and learning. Some strategies provided students with a generic set of skills, such as communication or planning (Prichard, Bizo, & Stratford, 2006, 2011; Prichard, Stratford, & Bizo, 2006), with positive results for learning. Other strategies were devoted to fostering constructive interpersonal social skills. For example, the ASK to THINK – TEL WHY©® programme (see King, 2007, for a review; King & Rosenshine, 1993) underscores the benefits of training students to ask insightful questions and to give relevant explanations. Considering that help seeking is adaptive (Järvelä, 2011), another strategy consists in training students in efficient help seeking and help giving (see Webb & Farivar, 1994). In the same vein, Gillies and her colleagues (Ashman & Gillies, 1997; Gillies & Ashman, 1996, 1998) reported the positive effects of interpersonal and collaborative skills training on effective cooperation, helping behaviour inside groups and skills learning. In this regard, the *Learning Together* method (Johnson, Johnson, & Holubec, 2008; Johnson, Johnson, & Smith, 1998) proposes promoting constructive interactions by teaching cooperative skills needed for the specific group task. Cooperative skills represent both interpersonal social skills and cognitive skills that can help students to work together on specific cooperative tasks. In summary, it appears that, in implementing a cooperative structure, it is useful to prepare students to cooperate. This background predicts that adding a specific preparation to cooperate contributes to achievement increases.

Challenges for cooperative learning implementation at university

In daily classroom work, few teachers actually propose regular cooperative learning at elementary and secondary schools (Baines, Blatchford, & Kutnick, 2003; Blatchford et al., 2003; Gillies, 2008; Pianta, Belsky, Houts, & Morrison, 2007) and considerable variations in the cooperative structure are reported (Antil, Jenkins, Wayne, & Vadasy, 1998; Emmer & Gerwels, 2002; Ruys, Van Keer, & Aelterman, 2012). Indeed, implementing cooperative learning involves many accommodations in teachers' practices. As pointed out by Gillies (2008), cooperative learning requires important changes in the way teachers control the classroom environment as well as in their instructional and organisational strategies compared to whole class or individual activities. Moreover, structuring group work activities with cooperative components requires a strong personal involvement. As a result, all these elements represent important challenges for its implementation.

We argue that cooperative learning is even less likely to be introduced at the university level. First, a university's organisational structure may render the implementation of structured cooperative learning groups difficult, as groups of peers change from class to class and are formed for 2 h a week for one semester (usually less than 4 months) at best. In addition, the development of social skills is often perceived as secondary and not particularly relevant by higher education teachers (Gillies, 2008); educational goals at university are essentially focused on the learning of academic knowledge. Second, higher education in Europe is clearly embedded in a competitive culture (as illustrated by official recommendations regarding credits based on normative comparison; European Commission, 2011) and perceived as such by students (Darnon, Dompnier, Delmas, Pulfrey, & Butera, 2009). Some research at the university level has emphasised that competitive social comparisons with partners may take place even during cooperative learning (Buchs & Butera, 2009; Buchs, Butera, & Mugny, 2004; Buchs, Pulfrey, Gabarrot, & Butera, 2010; Lambiotte et al., 1987). The competitive climate at university is therefore likely to interfere with cooperative learning implementation and benefits.

University students are likely to be focused on performance goals, and they are neither socialised for cooperative learning nor used to it; thus, in order to boost cooperative benefits for learning outcomes, preparation for cooperative learning must overcome these challenges by explaining why and how to cooperate in the specific academic task. Moreover, we argue that proposing a way to interact that is relevant to the task is likely to promote students' perception that they may gain competence while working together. This preparation should enhance their competence perception in the academic task conducted together.

Competence perception as mediator of cooperative learning benefits

Various reviews indirectly suggest that competence perception may be influenced by cooperative learning (Johnson & Johnson, 1989; Slavin, 1990). Indeed, some variables are evoked that are related to competence perception, such as the willingness to engage in difficult tasks and to persist despite difficulties (Johnson & Johnson, 1989), but, surprisingly, self-efficacy and competence perception as such are not mentioned as core outcomes of cooperative learning (e.g. self-efficacy is not mentioned in Johnson & Johnson, 1989, 2009; or Slavin, 1983a).

We contend that it is important to investigate whether cooperative learning can foster competence perception, as the perception of being capable of mastering a task is widely documented to be a powerful determinant of academic achievement (for a review, see Bandura, 1997; Schunk & Pajares, 2005). Accordingly, qualitative results from a study by Courtney, Courtney, and Nicholson (1994) indicated that students experiencing cooperative learning during a semester in an introductory statistics course reported a positive shift in their motivation and self-efficacy, as well as reduced anxiety. Townsend and Wilton (2003) reported a higher self-concept in mathematics and lower anxiety after one semester of using cooperative learning in a statistics for social sciences course. However, in these two studies, no comparison was provided with a condition without cooperative learning for the same course. Other investigators stress that cooperative learning, compared with individual methods, may enhance the perception of competence (Hänze & Berger, 2007), even in difficult contexts (academic self-efficacy in mathematics and French for vocational trainees, Darnon, Buchs, & Desbar, 2012; education students' perceived competence in statistics, Krause, Stark, & Mandl, 2009); however, in these studies, the mediational role of competence perception in the effect of cooperative learning on learning outcomes is not clearly documented.

Thus, cooperative learning is likely to promote high levels of learning at all levels of instruction (Johnson & Johnson, 2009) and may enhance competence perception (Darnon et al., 2012; Krause et al., 2009). Data are missing, however, that explore the mediational role of competence perception in the relationship between cooperative structure and learning outcomes. We propose that a cooperative learning activity in which students are prepared for cooperation by explaining why and how to cooperate in the specific task is likely to enhance their corresponding competence perception and learning outcomes. The aim is to test the mediational role of competence perception of the academic task in the link between cooperative learning structure and learning outcomes.

The present research: a cooperative nudge to improve statistics learning for psychology students

Difficulties in statistics and quantitative methods have been widely illustrated for students in the educational sciences (Townsend, Moore, Tuck, & Wilton, 1998) and the social sciences (Courtney et al., 1994; Krause et al., 2009), as well as for psychology students (Tomasetto, Matteucci, Carugati, & Selleri, 2009). These students are aware of their difficulties in statistics, they evaluate statistics as a difficult discipline, and they feel a specific form of anxiety towards statistics (Tomasetto et al., 2009). Of importance for the present research, Krause et al. (2009) suggested that subjective outcomes (e.g. perceived competence) are relevant for statistics learning because of students' poor self-efficacy.

Thus, we proposed a study in a class of statistics for psychology students, in which the learning outcomes of students who work alone for the exercise phase (*individual work*) would be compared with those of students who work in two conditions with an overall cooperative learning framework comprising the aforementioned three classic basic elements (Davidson, 1994; Sharan, 2010): positive interdependence, individual responsibility and promotive interactions. Overall, the cooperative structure should contribute to achievement increases. However, because of the above considerations on the competitive culture at university, we devised two cooperative dyadic conditions (see Methods section): *cooperative dyadic instructions* (structuring the three basic components of cooperative learning) and *cooperative dyadic interactions* (cooperative dyadic instructions with a cooperative nudge regarding why and how to cooperate).

Indeed, we suggest, first, that students are not willing to cooperate spontaneously; therefore, our intervention in the *cooperative dyadic interactions* condition, as compared with the *cooperative dyadic instructions* condition, proposed to prepare students to cooperate by giving them explicit norms for cooperation (why they should cooperate). Second, we suggest that students are not used to cooperating; therefore, they may experience difficulties in doing so. Our intervention also prepared students to demonstrate three cooperative skills identified by the regular teacher to be highly relevant for the specific task that they had to work on (how to cooperate). This preparation should contribute to achievement increases.

Competence perception refers to the perception of being capable of mastering the task. The literature on cooperative learning reviewed above has long shown that working cooperatively with another student may enhance actual mastery of a task compared to individual work (e.g. Johnson & Johnson, 1989). We argue that proposing a way to interact that is adapted to the task can help students to work well together and to master the task. Therefore, adding cooperative elements to the task – from none in the individual work condition, to a cooperative structure in the cooperative dyadic instructions condition, to a cooperative structure facilitated by the cooperative nudge for why and how to cooperate in the cooperative dyadic interactions condition – should progressively favour cognitive (mastery of the task) and socio-cognitive outcomes (competence perception). Thus, across the three conditions, we should observe a progressive increase in perception of self-competence and mastery of the task. We predicted that individual learning outcomes after the exercise phase would follow a progressive increase across conditions, from individual work to cooperative dyadic instructions to cooperative dyadic interactions (H1), as well as a progressive increase for students' competence perception concerning statistics exercises (H2). As this latter perception is particularly important for psychology students studying statistics, it should mediate the effect of the experimental conditions on individual learning outcomes (H3).

Moreover, when students work together, that is, in the two cooperative conditions, a cooperative nudge explaining why and how to cooperate should enhance social outcomes. In this study, we thus aimed to check whether students report more cooperation and less competitive social comparison activities with the cooperative nudge than without it.

Methods

Participants

The intervention was conducted with first-year psychology students in a medium-size Swiss university during a regular workshop in statistics that follows an introductory statistics lecture. This theory-based intervention was conducted in collaboration with the statistics teacher, and the data collection concerned all the students attending this teacher's class. The lecture is usually given once a week for all enrolled students, and then, each student attends a workshop that involves a small group of students. In the workshop, three or four exercises are proposed each week and students work either on the exercises alone or with peers, if they prefer, while the regular teacher and two assistants answer students' questions and give advice. If necessary, explanations are given to the class collectively. At the end of the session, a collective correction is proposed. For the present study, we chose one session of this workshop to conduct our intervention. The statistics teacher agreed that an external experimenter conducted the workshop in three different ways, depending on experimental conditions. Students ($N = 187$, mean age = 20.36 years) were randomly assigned to one of the three conditions: 75 to the *individual work* condition (mean age = 20.87 years, 3 males), 56 to the *cooperative dyadic instructions* condition (mean age = 20.09 years, 8 males) and 56 to the *cooperative dyadic interactions* condition (mean age = 19.95 years, 7 males). In the two dyadic conditions, six to eight students arrived at the workshop at the same time in order to form three to four dyads. Students were required, if possible, to work with same-sex partners whom they did not know before the workshop. In total, the dyadic conditions comprised 28 dyads in the cooperative instructions condition (2 mixed dyads, 3 male dyads and 23 female dyads) and 28 dyads in the cooperative interactions condition (3 mixed, 2 male dyads and 23 female dyads).

Procedure

In the three conditions, the study was presented as an investigation of how students autonomously use resources or strategies regarding probability problem-solving, and how students process statistics information. The workshop (90 min) included four parts: individual review, exercise phase in one of the three different conditions, questionnaire on perceptions and individual learning test (see Table 1).

Twenty minutes were first devoted to an individual review of the preceding lecture about set theory. A written booklet summarised the content of the lecture with some examples of different strategies that can be useful to complete the exercises. This information was elaborated by the experimenter, and then commented and revised by the regular teacher. After the individual review, students had 30 min for the exercise phase, with two exercises to master and complete. The exercise phase varied as a function of the experimental condition (individual work, cooperative dyadic instructions and cooperative dyadic interactions; see Independent variable section). Students accessed the course booklet and strategies during the exercises. We explained that the purpose of the exercises was to give students the opportunity to prepare themselves for the individual learning test that would take place without any support. They then filled in a questionnaire reporting their feelings about the exercises (see Potential mediator and Manipulation checks sections) before answering the individual learning test (see Dependent variable section). In all three conditions,

Table 1. Summary of the procedure.

	Condition		
Steps	Individual work	Dyadic cooperative instructions	Dyadic cooperative interactions
1. Individual review (20 min)	Summary of the lecture Statistics strategies	Summary of the lecture Statistics strategies	Summary of the lecture Statistics strategies
2. Instruction for exercise phase (5–15 min)	Individual work	Positive interdependence, individual responsibility, promotive interactions	Positive interdependence, individual responsibility, promotive interactions + cooperative nudge explaining why and how to cooperate (10 min)
3. Exercise phase (30 min)	Two statistics exercises with reasoning explained	Two statistics exercises with reasoning explained	Two statistics exercises with reasoning explained
4. Questionnaire	Competence perception	Competence perception Checks	Competence perception Checks
5. Individual learning test (outcomes) (10 min)	Two statistics exercises	Two statistics exercises	Two statistics exercises

we invited students to make their reasoning explicit by writing the intermediate steps they went through to reach the answer, and by writing explanations during the exercises and individual learning test. A focus on learning and mastery was introduced in all conditions.

Measures

Potential mediator

Students' competence perception was assessed after the training phase and before they filled in the individual learning test and were operationalised through a three-item scale, with a response range from 1 (*not at all*) to 7 (*completely*). The questions explicitly focused on their competence perception during the exercises they worked on in the training phase. Two questions were inspired from Hänze and Berger's (2007) experience of competence: 'I realised that I had understood some things' and 'I felt I was able to master the work'. The remaining question was as follows: 'I felt I was competent'. The three questions were aggregated ($\alpha = .84$, $M = 4.76$, $SD = 1.23$).

Manipulation checks

Before answering the individual learning test, students in the two dyadic conditions reported their perceived level of cooperation and competitive social comparison between partners[1].

Perceived level of cooperation. Students in the two dyadic exercise conditions answered five questions on a 7-point scale to assess their perceived level of cooperation inside the dyad ($\alpha = .90$, $M = 5.75$, $SD = 1.10$). They reported the extent to which they were comfortable in the dyad, ranging from 1 (*not at all*) to 7 (*completely*), inspired by Hänze and Berger (2007); how they evaluated the quality of the relationship inside the dyad, as well as the collaboration in the dyad, from 1 (*very bad*) to 7 (*very good*); and the degree of cooperation with their partner, from 1 (*very weak*) to 7 (*very strong*), inspired by Buchs and Butera (2001). Finally, they had to choose the extent to which they felt as though they were *two individuals* (1) or *a team* (7), adapted from Driskell, Salas, and Johnston (1999).

Perceived competitive social comparison activities between partners. Competitive social comparison activities between partners (Buchs et al., 2004) were measured ($\alpha = .80$, $M = 2.84$, $SD = 1.08$) by asking them how frequently they checked that what their partner said was correct, evaluated their partner's competence, tried to present themselves as more competent than their partner, wondered how to appear competent, tried to impose their own point of view, and questioned their partner's competence (from 1 = *very rarely* to 7 = *very often*).

Dependent variable

Individual learning outcomes were assessed at the end of the session, and students were not allowed to use any support during the test. They had 10 min to individually fill in the learning test, which had been devised in collaboration with the regular statistics teacher and following his own usual way of testing. The test included two types of questions: (a) a replication of the exercises completed in the previous steps of the study, but using new data (data not discussed during the statistics lecture); and (b) completely new exercises that required the generalisation of the mathematical principles of set theory to a real-life situation. The first exercise was rated from 0 (for an incorrect answer with no explanation) to 2 points (for a correct answer with explanation). The second, longer exercise was rated from 0 (for an incorrect answer with no explanation) to 4 points (for a correct answer with explanation). For these two exercises, we introduced intermediate scores according to the usual grading used by the regular teacher, taking into account the combination of the answer and the explanation. The learning outcomes score consisted of the sum of the above two scores and ranged from 0 to 6, the usual assessment range in Switzerland. The second author, who had developed all the material for the intervention in collaboration with the regular statistics teacher (the written booklet regarding the lecture, the exercises and the post-test), scored all learning outcomes, while being blind to conditions. In order to provide inter-judge reliability, a second judge scored the same outcomes. The reliability (Krippendorff's alpha reliability = .91, confidence interval [.86–.93]; $r(187) = .91$; Cronbach's $\alpha = .95$) was good enough to work with the scores of the second author. The mean score ($M = 2.69$, $SD = 1.34$, minimum = 0, maximum = 6) indicated that statistics are not easy for these psychology students (the pass level is 4), which is a well-known problem in psychology curricula.

The statistics teacher took the opportunity of the present intervention to ask his students some questions he was interested in. As this additional information is not relevant for our content, we do not present it here.

Independent variable

The independent variable corresponds to the instructions for the exercise phase (two exercises for 30 min). Students worked individually, or in dyads with cooperative instructions, or in dyads with cooperative interactions.

In the *individual work condition*, students were to solve the exercises alone with the booklet and the available examples of different strategies that can be useful to complete the exercises. They were invited to write down the steps they went through during the exercises and to explain their reasoning.

In both dyadic conditions, we introduced cooperative instructions that correspond to the common components for cooperative learning (Davidson, 1994; Sharan, 2010): positive goal interdependence, individual responsibility/accountability and encouragement of promotive interactions. These components were introduced with a short and simple procedure because the aim of the intervention was to test an easy way for university teachers to support cooperative learning, even if they are not already involved in formally using cooperative learning. We operationalised positive interdependence via positive goal interdependence, in line with the social cohesion hypothesis (Johnson & Johnson, 1989; Mesch, Johnson, & Johnson, 1988), because this is documented to be sufficient, especially for challenging tasks (Buchs, Gilles, Dutrévis, & Butera, 2011; Cohen, 1994). In the *cooperative instructions condition*, we made the goal of the exercises explicit: For both partners to master the content of the lecture and to help each other during the problem-solving exercises by making sure that each partner is able to solve the individual learning test (positive goal interdependence). We stressed that they were responsible for supporting their partner's learning (individual responsibility), and we proposed that each student uses a different colour pen so that the researcher would be able to investigate how they worked together (individual accountability). We also invited students to explain their reasoning to their partner and to help each other (promotive interactions).

In the *cooperative interactions condition*, we introduced the same three components and we added a cooperative nudge with two additional elements. First, we introduced positive norms towards cooperation by making the value of cooperation apparent for individual learning and explaining why students should cooperate. We indicated that several studies in psychology and education have demonstrated that explaining to someone else how one goes through an exercise produces a better understanding for oneself. Accordingly, we also made it clear that listening to the partner allows one to discover alternative strategies and reinforces one's own understanding. We emphasised that explaining, active listening and discussion about problem-solving allow a better understanding of the statistics principles and facilitate the application of principles in various contexts. Second, we explained how to cooperate by introducing three specific cooperative skills that the regular teacher identified as highly relevant for the statistics task to be solved: (a) explain how one processes problems, (b) be sure to understand the way the partner processes problems and (c) suggest alternative ways to process problems. After the introduction of these skills, we discussed how to translate these cooperative skills into a set of operational procedures (words and actions) suitable for the task (see Table 2). These additional cooperative nudges took less than 10 min.

Table 2. Cooperative skills introduced in the cooperative interactions condition.

How to translate cooperative skills into action	How to translate cooperative skills into words
I explain how I process problems	
• I'm involved in the discussion • I try my best to be as clear as possible	• I explain the different steps ('I start by …, then I …') • I explain my rationale ('I do it because …') • I explain my strategies • I explain how I concretely do something
I check that I understand the way my partner processes problems	
• I encourage my partner to develop his/her ideas • I let my partner explain without stopping him/her • I listen to my partner's proposition even when I don't agree	• I express my understanding ('All right, I understand') • I express my difficulties ('I do not understand; could you please explain again?') • I reformulate what my partner says in order to be sure I understand • I ask questions to invite my partner to be more explicit • I check for potential problems
I suggest alternative ways to process the problems	
• I'm involved in the discussion	• I suggest some alternatives ('and what if we started by … I would rather do …') • I propose different alternatives

As mentioned above, this study was an intervention conducted in cooperation with the statistics teacher, and the teacher was also interested in the influence of feedback type on students' perception of the work they do in the workshop. We therefore introduced two different feedback anticipations: Students anticipated receiving either comments on their work or grades. Results showed neither main nor interaction effect of feedback anticipation on the variables reported in this manuscript, and therefore, the data were collapsed across these two conditions. Results are available on request from the authors.

Results[2]

Overview of analyses

The correlations between variables are presented in Table 3. In order to satisfy the conditions of application of general linear modelling, we checked both normality and homogeneity of variances (Judd, McClelland, & Ryan, 2008). We applied data transformations when required in order to re-establish these conditions. Moreover, two participants were removed from the database because of uncommon Studentized Deleted Residual (SDRs; Judd et al., 2008): one participant in cooperative instructions (SDR = −3.44) and one participant in cooperative interactions (SDR = −3.73). The final sample comprised 185 students; observed and transformed means with standard deviations are presented in Table 4.

In order to test our three hypotheses, we adopted a model comparison approach (Judd et al., 2008) and used two orthogonal contrasts. Our predictions involve a progressive increase across the conditions. Our theoretical background did not permit to predict whether this increase would be either linear or multiplicative, so we decided to remain on safer ground and to test a linear contrast. The first contrast, L1, represented the linear progression (a progressive increase: −1 for individual, 0 for cooperative instructions and +1 for cooperative interactions), whereas the orthogonal contrast, D2, represented the deviation from linearity (+1, −2, and +1, respectively; see Table 4). The proper use of contrast analysis requires L1 to be significant and D2 to be non-significant (Abelson & Prentice, 1997).

Individual learning outcomes

As a consequence of lack of normality, a log transformation was performed on individual learning outcomes.

Table 3. Correlations between variables for the two dyadic conditions (n = 109).

	1	2	3
1. Individual learning outcomes			
2. Competence perception	.23*		
3. Perceived level of cooperation in dyadic conditions	−.05	.12	
4. Perceived competitive social comparison activities between partners	−.01	.15	−.27**

Notes: The correlation between competence perception and individual learning outcomes for all students (n = 186) is .26**.
*p < .05; **p < .01.

Table 4. Contrast coding and descriptive statistics for the main dependent variables as a function of the three training conditions.

		Individual	Cooperative instructions	Cooperative interactions
Linearity contrast L1		−1	0	+1
Deviation from linearity D2		+1	−2	+1
Assessed individual learning outcome	*M*	2.51	2.70	3.03
	SD	1.19	1.39	1.37
Transformed individual learning outcome	*M*	.52	.54	.58
	SD	.14	.16	.15
	N	75	55	55
Competence perception during training	*M*	4.50	4.93	5.02
	SD	1.19	1.21	1.20
	N	75	54	55

As predicted by H1, the L1 contrast showed that transformed individual learning outcomes progressed linearly and significantly from the individual work condition ($M_{\text{transformed}} = .52$) to the cooperative instructions condition ($M_{\text{transformed}} = .54$) to the cooperative interactions condition ($M_{\text{transformed}} = .58$), $b = .03$, $t(182) = 2.26$, $p = .03$, $\eta_p^2 = .03$. The deviation from linearity D2 was not significant: $b = .00$, $t(182) = .52$, $p = .60$, $\eta_p^2 = .00$. The two contrasts explained a weak proportion of the variance ($R^2 = .03$), but the gain in individual learning outcomes of the cooperative interactions condition in comparison with the individual condition (the first and third experimental groups) corresponded to +.52 of 6 points (see Table 4; $M_{\text{assessed}} = 2.51$, 2.70 and 3.03, respectively, for the three conditions); this difference may be important for students socialised within the Swiss system, to the extent that grades increase by .25 points.

Competence perception

As predicted by H2, the L1 contrast showed that competence perception progressed linearly from the individual work condition ($M = 4.50$) to the cooperative instructions condition ($M = 4.92$) to the cooperative interactions condition ($M = 5.02$), $b = .26$, $t(181) = 2.45$, $p = .02$, $\eta_p^2 = .03$, whereas the deviation D2 was not significant, $b = -.05$, $t(181) = -.82$, $p = .42$, $\eta_p^2 = .00$ (see Table 4). Once again, the two contrasts explained a weak proportion of variance ($R^2 = .04$).

Mediational analysis

Following up on the above analyses, the mediator was introduced in a regression analysis at the same time as the two orthogonal contrasts (L1 and D2) to predict the transformed individual learning outcomes (see Figure 1; $R^2 = .09$). When students' competence perception was entered, the effect of the linear contrast L1 was reduced and became non-significant ($b = .02$, $t = 1.68$, $p = .10$, $\eta_p^2 = .02$, Sobel test = 2.02, $p = .05$), while the effect of students' competence perception remained significant ($b = .03$, $t = 3.53$, $p < .01$, $\eta_p^2 = .06$). Thus, the perception of competence is a possible mediator of the linear progression in learning outcomes from the individual learning condition to the cooperative interactions condition induced by the cooperative learning structure.

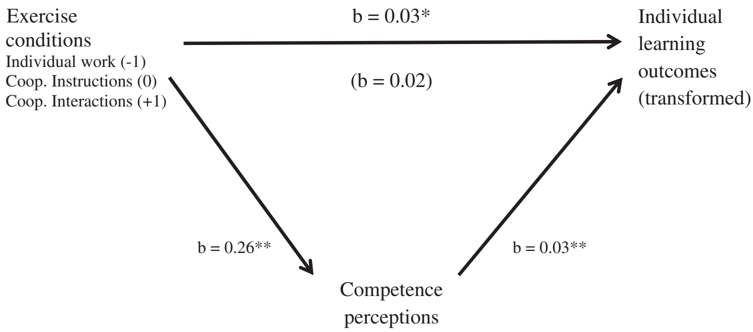

Figure 1. Mediational role of students' competence perceptions. Coop. = cooperative.
Notes: *$p < .05$; **$p < .01$.

Manipulation checks

Results for manipulation checks in the two dyadic conditions are presented in Table 5. Two additional outliers were dropped from the sample (final $N = 108$), one on perceived cooperation (in the cooperative instructions condition; SDR = −4.59), and one on reported social comparison (in the cooperative interactions condition; SDR = 3.63).

Perceived level of cooperation

We applied a cubic transformation because of the heterogeneity of variance. Students who did the exercises in the cooperative interactions condition reported more cooperation ($M_{\text{reported}} = 6.00$, $M_{\text{transformed}} = 228.66$) than did students in the cooperative instructions condition ($M_{\text{reported}} = 5.59$, $M_{\text{transformed}} = 193.57$), $b = 55.10$, $t(105) = 2.08$, $p < .04$, $\eta_p^2 = .04$.

Perceived competitive social comparison

Results also indicated that students reported less competitive social comparison activities when they did the exercises in the cooperative interactions condition ($M = 2.53$) than they did in the cooperative instructions condition ($M = 3.07$), $b = -.54$, $t(105) = -2.77$, $p < .01$, $\eta_p^2 = .07$.

Table 5. Descriptive statistics for the manipulation checks in the two cooperative conditions.

		Cooperative instructions	Cooperative interactions
Reported perceived cooperation	*M*	5.59	6.00
	SD	1.11	.86
	N	53	54
Transformed perceived cooperation	*M*	193.57	228.66
	SD	92.82	81.32
	N	53	54
Reported social comparison	*M*	3.07	2.53
	SD	1.07	.94
	N	53	54

Discussion and conclusion

In this study, we argued that university students are neither socialised for cooperative learning nor used to it and that it is therefore important to prepare them to cooperate in order to boost the benefits of cooperative learning. We argued that adding cooperative elements to the learning environment will progressively increase students' perception of competence on that specific task that will in turn progressively enhance individual learning outcomes.

The results revealed that the cooperative benefits increased with the cooperative structure: Individual learning outcomes in statistics progressed linearly from individual work to cooperative instructions to cooperative interactions. In other words, it appeared that a structured cooperative exercise enhances cooperative gains when students are explicitly told why and how to be. This specific cooperative nudge seems particularly well suited for addressing the challenges of implementing cooperative learning in the overall competitive atmosphere at university, because this condition significantly enhanced perceived cooperation and reduced reported competitive activities as compared with the cooperative instructions condition.

These results, concerning the role of preparation in cooperation, represent the first contribution of the present study. As stated in the introduction, cooperative learning does not result in positive gains in all studies that have been analysed in meta-analyses (e.g. Johnson & Johnson, 1989), and the implementation of cooperative learning remains a challenge, especially at university, because of its organisational structure, competitive climate and little concern regarding social objectives. Our theory-based intervention demonstrates that a nudge to cooperate, in which students are given an explanation as to why and how to cooperate, is likely to compensate for university students being neither socialised for cooperative learning nor used to it. This finding therefore explicitly stresses the positive value and benefits of cooperation for learning; actively implementing targeted cooperative skills is important. Future research should study to what extent such an intervention could be effective at the level of primary and secondary school, as preparation for cooperation has also shown positive effects at school. Indeed, recent results revealed that a short intervention explaining pupils why and how to cooperate in a specific activity (a controversy) yielded some positive effects on constructive interactions at middle school (Golub & Buchs, 2014).

What process may account for these results? The second contribution of the present study is that it identifies a potential mediational role of students' perception of competence in the effects of the cooperative learning structure on learning outcomes. We suggested that the reason for predicting more positive learning outcomes in the condition with a cooperative nudge is that this procedure should increase the students' competence perception regarding the statistics exercises they work on. And indeed, our results showed that competence perception increased across conditions from individual work to cooperative instructions to cooperative interactions and that it fully mediated the effect of exercise conditions on learning outcomes. In line with Bullock, Green, and Ha (2010), competence perception could be considered as a potential mediator. This potential mediational effect is an important result because although the literature on cooperative learning indirectly suggests that competence perception may be affected by cooperative learning, and in turn may affect learning outcomes, this suggestion has so far received no empirical support. The present research shows the potential mediational role of students' perception of competence in the effects of the cooperative learning structure on learning outcomes.

In our study, perceived level of cooperation and the perceived competitive social comparison were not related to students' learning outcome. This absence of relation can be understood in the challenging context of statistics learning. As students report low self-efficacy and strong anxiety in statistics (Courtney et al., 1994; Townsend & Wilton, 2003) and they are aware of their difficulties in statistics (Tomasetto et al., 2009), subjective outcomes such as feelings of competence may become particularly salient and relevant (Krause et al., 2009) for learning outcomes. And indeed, in our study, only the feelings of competence were related to learning.

An important limitation concerns the weak proportion of explained variance (R^2 from .03 to .09), although the results are significant. Weak effect sizes are not unusual and can be explained by the students' objectively low proficiency in mathematics and statistics that may render their attitudes resistant to change and explain why progress in learning is difficult (e.g. Courtney et al., 1994; Krause et al., 2009; Moriarty, Douglas, Punch, & Hattie, 1995). Future research with a longer intervention and a regular reiteration of the instructions may result in larger effects. A second limitation concerns the lack of long-term learning measures. As competence perception appeared to be a crucial intermediary to explain the effect of cooperative learning on learning outcomes, it may favour long-term benefits.

Despite these limitations, our results showed that an additional cooperative structure enhances learning, thanks to the promotion of competence perception. The good news for teachers willing to implement cooperative learning is that this preparation required only a limited amount of time and resources. A single collective training session for less than 10 min was sufficient. Therefore, this type of intervention could find a place even in a busy programme at university. This intervention favours, moreover, the perception of competence in statistics and progress in statistics learning, a recurring challenge when teaching statistics to psychology students.

Disclosure statement

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Notes

1. The three conditions were designed to range from lower to higher involvement in learning statistics. However, one might argue that they also range from lower to higher cognitive demand, to the extent that the individual condition contains fewer elements to attend to than does the cooperative instructions condition, which in turn contains fewer elements than the cooperative interactions condition; in this respect, we checked students' involvement during their exercises. Results showed that students' involvement linearly increased from individual work to cooperative instructions to cooperative interactions.
2. In order to be fully transparent, we also present the results for all hypotheses with all participants ($N = 187$) and no transformation. For *learning outcomes*, the L1 contrast showed that individual learning outcomes progressed linearly and significantly from the individual work condition ($M = 2.51$) to the cooperative instructions condition

($M = 2.65$) to the cooperative interactions condition ($M = 2.98$), $b = .24$, $t(184) = 1.99$, $p = .05$. The deviation from linearity D2 was not significant: $b = .03$, $t(184) = .42$, $p = .67$. For *competence perception*, one student did not answer the questions ($N = 186$). Competence perception progressed linearly from the individual work condition ($M = 4.50$) to the cooperative instructions condition ($M = 4.86$) to the cooperative interactions condition ($M = 5.03$), $b = .26$, $t(183) = 2.48$, $p = .01$, whereas the deviation D2 was not significant, $b = -.03$, $t(183) = -.48$, $p = .63$. When students' competence perception was entered as a mediator, the effect of the linear contrast L1 was reduced and became non-significant, $b = .17$, $t = 1.42$, $p = .15$, while the effect of students' competence perception remained significant ($b = .26$, $t = 3.33$, $p < .01$). Regarding the *manipulation check* for the two cooperative conditions ($N = 112$ but one participant did not answer, final $N = 111$), students who did the exercises in the cooperative interactions condition reported more cooperation ($M = 5.99$) than did students in the cooperative instructions condition ($M = 5.53$), $b = .46$, $t(109) = 2.26$, $p < .03$. Students reported less competitive social comparison activities when they did the exercises in the cooperative interactions condition ($M = 2.58$) than they did in the cooperative instructions condition ($M = 3.06$), $b = -.49$, $t(109) = -2.41$, $p < .02$.

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