Computer anxiety and computer competency instruction: Aptitude-treatment-interaction effects

Valentina McInerney
Dennis M McInerney
Lawrence Roche

University of Western Sydney, Macarthur

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Abstract

This paper reports on a study designed to examine the comparative effects of cooperative group learning and direct teaching on student acquisition of computing competencies, as well as the comparative efficacy of these modes of teaching on the reduction of computer anxiety among students.

Using a quasi-experimental design two equivalent groups of students completing computer coursework were given alternative modes of delivery of an introductory computing course. One group received "training" through direct teaching, and the other group received "training" through direct teaching plus collaborative self-regulated learning facilitated by the instructor.

In this study we report on the differential effects of each treatment for high anxious versus low anxious computing students and discuss the results in the context of effective teaching models for introductory computing courses.

Many computer education courses offered at tertiary institutions throughout Australia either ignore the issue of student anxiety, or are based on the belief that gaining experience with computers (throughout a course) will reduce computer anxiety. The controversy regarding the effects of computer experience on student anxiety and achievement, as cited above, cause the present authors to question the wisdom of ignoring the impact of computer contact on student anxiety, or presuming that such contact, per se, will alleviate anxiety.

In an earlier study (McInerney, McInerney & Sinclair, 1994) the authors sought to examine the effects of "forced" computing experience, such as compulsory computing courses required during teacher training, on the computer anxiety of first year teacher education students. This type of experience is distinct from voluntary computer interaction which would be predicted to cause little anxiety.

The evidence from this study gave some support to previous findings that explain computer anxiety from a social learning perspective. Personal ownership of computers, familiarity with a variety of computer applications and completing a compulsory word processing course all reduced anxiety for first year teacher trainees.

A simplistic explanation, however, that increased computer experience alone would reduce computer anxiety did not account for the complex interactions between the individual and situational variables found in this study: a number of students still remained anxious at the end of the Educational Computing course. Clearly, for some individuals, increased computer experience did not necessarily alleviate anxiety, especially when such experience formed part of formal tertiary coursework.

Research into the types of computer training for students that best prevent initial anxiety from escalating, perhaps by focussing on building confidence and a sense of personal control in a non-threatening learning environment, individualised if necessary, was urgently needed. It was in this context that the following study was devised. In short, the aim of the present research was to determine if there might be an instructional approach which could minimise student anxiety when learning to use computers in a compulsory learning situation.

Two forms of treatment were designed: first, a program of instruction based upon principles of direct instruction, and second, a program of instruction based upon direct instruction plus cooperative self-regulated group work. Our major focus was to examine whether the two treatments were differentially salient to high and low anxious students. Previous research in the areas of self-regulated and cooperative learning has demonstrated the power of these approaches in reducing anxiety about mastery, raising self-esteem, and enhancing achievement. But does this approach work for students who are initially high anxious? We wished, therefore, to examine whether high anxious students within a direct teaching treatment benefitted more from a highly structured approach, while high anxious students in a collaborative self-regulated group treatment beneffited less from the less structured approach. It is more than likely that the low anxious students remained low anxious at the end of the subject irrespective of treatment. The appropriate way to test this is through aptitude-treatment-interaction analyses.

The hypotheses tested were that there would be no significant aptitude-treatment-interaction effects on anxiety outcome variables for students of varying levels of computer anxiety at pretest undergoing two alternative forms of computer training.

Specifically, during this study we:

1.Conducted quasi-experimental research using two equivalent classes in the subject Introduction to Computers. One class was taught using direct instruction. The other class was taught using a program based upon Direct Instruction plus collaborative self-regulated learning. The content covered in each class was equivalent, and assessment modes were the same.

2.Measured student anxiety scores at pretest and posttest, and related these to modes of treatment.

3.Observed, described and evaluated the program in operation using qualitative observational techniques (regular interviews with lecturer and selected high and low computer anxious students, as well as monitoring of student and lecturer logbooks).

4.Selected four high-anxious students and four low-anxious students (two from each group) for close observation through case-work study methodology to give the research depth and verisimilitude.

This paper reports on parts one and two of the study with a particular focus on the aptitude-treatment-interaction effects.

Methodology

The research reported in this paper was designed to examine the comparative efficacy of two modes of teaching (Direct Instruction alone and Direct Instruction plus Collaborative Self-Regulated Learning) on the reduction of computer anxiety among students.

Sample

Two equivalent groups of students completing compulsory computer coursework in the subject Introduction to Computers were randomly assigned to alternative modes of delivery taught by the same instructor. The classes were selected from the Faculty of Arts and Social Sciences at a regional university in NSW, Australia. One group (n=16, m=10, f=6) received computer "training" through direct instruction, and the other group (n=15, m=7, f=8) received "training" through direct instruction and the development of collaborative self-regulated learning strategies. The average age of the students was 20 years.

Procedure

Students attended a one-semester course called Introduction to Computing which comprised a one hour mass lecture on the theory of the

topic being taught at the time, and a two hour tutorial in the computer lab using IBM PS1 machines to extend the lecture content and gain hands-on experience.

Pretest/posttest questionnaire instruments were administered to elicit information regarding base levels of computing competence in the areas to be taught , namely, DOS, wordprocessing (WordPerfect 5.1), database (DBase 4) and spreadsheet (Lotus 123) applications. Furthermore, computer anxiety levels were determined using the validated McInerney and McInerney Computer Anxiety and Learning Measure - CALM (McInerney, McInerney & Roche 1994). Typing speed and accuracy was assessed at the commencement of the course using the KeyCoach program.

Treatment

The direct instruction model has traditionally been adopted for skills training such as in computing. Research in the area of direct instruction (or explicit teaching) has identified the following

teaching functions of this model: present new material, provide guided and independent practice, and review regularly to consolidate learning (Rosenshine, 1986). Such teacher-directed instruction formed the basis of one treatment received by students.

Self-regulated learning has been conceptualised as having three major components: student metacognitive strategies for planning, monitoring, and modifying their own learning; student management and control of their effort in learning, and student cognitive strategies used to learn, remember, and understand new material such as organisation, rehearsal and elaboration (Pintrich & DeGroot, 1990). These aspects were included in the research design. For example, at the conclusion of their two week Practical Review period, students were asked to predict what grades they would achieve in their Practical Test.

Finally, the Cooperative learning structure implemented met the following criteria as outlined by Johnson & Johnson, (1991): positive interdependence, face to face interaction, individual accountability, collaborative skills and group processing.

It is worth noting that both groups in this study received equivalent structured input from the tutor for the first half of each two hour tutorial. The direct instruction group were then allowed to practise individually, calling on the tutor for help as required.

Students in the experimental group, on the other hand, received modeling and practice in using higher-order questions in an effort to develop metacognitive strategies which would assist their learning and recall of new information. This treatment was based on King's (1991, 1992, 1993) reciprocal peer-questioning approach, and especially focussed on student use of generic question stems to produce their own questions in order to clarify their understanding during the examination review time.

Analyses

Multiple regression analysis was used to study potential aptitude-treatment-interaction effects. For each analysis the following variables were utilized:

(i). Two covariates: the first was the relevant pretest level of anxiety on each of the anxiety scales drawn from CALM: gaining initial computing skills; competence with computers; handling computer equipment; receiving feedback on computer competence; learning about computers; positive sense of control; negative sense of control; computer self concept; positive view of self; negative view of self; state anxiety in computing situations; worry state; distractability; physiological symptoms; and happiness state. The second covariate, a computed one representing students' prior competence at computing reflected through their mastery of DOS, word processing, database, and spreadsheet applications, was used in each analysis to control for prior competence.

(ii). Posttest anxiety scores were used as the criterion variables in appropriate analyses

(iii). A dummy variable was constructed representing the two groups, and

(iv). A variable representing the interaction term between appropriate pretest levels of anxiety and the grouping variable was computed for each scale.

The variables were entered in three blocks using SPSS regression procedure. The two covariates were entered in steps 1 and 2, the grouping variable on step 3, and the interaction term on step number 4. Output was examined to ascertain if the interaction terms contributed to a significant change in the F value at step 4 for each of the separate analyses.

Hypotheses:

There will be no significant aptitude-treatment-interaction effects.

Results and discussion

Preliminary analyses were conducted to ascertain whether the two groups were equivalent on prior experience and ability, as well as on initial levels of anxiety. Using a computer competency checklist designed by the researchers, students were asked to report on their level of competence with DOS, wordprocessing, database and spreadsheet

applications. Oneway analyses of variance indicated that there were no significant differences between groups on prior levels of competence on each of these measures. Oneway analyses of variance on the pretest anxiety scales (CALM scales) also indicated that there were no significant differences between treatment groups on any of the scales prior to the commencement of the treatment.

Final assessment results for both groups indicate that there were no achievement differences between the two groups at the end of the treatment, nor were there any interactions of initial level of anxiety and treatment group on achievement outcome variables. This evidence suggests that irrespective of initial levels of anxiety, students performed equally well under both treatment conditions. Our focus, therefore, is clearly on the potential aptitude-treatment-interaction effects on the anxiety outcome variables.

Pedhazur and Schmelkin (1991, p.558) suggest that in order to minimise Type II error in aptitude-treatment-interaction studies, a relatively large alpha (e.g., .10; even .25) be used for tests of interactions. Owing to the small sample size and reduced degrees of freedom in this study we have selected .25 as the criterion probability for examining interaction effects. Table 1 shows the results of our analyses. It is clear from this summary that when prior competence in using computers is controlled for, student's initial level of anxiety interacts with the teaching method employed in producing differential effects on a number of anxiety outcome variables. We plotted four significant interactions to ascertain the direction of the effects. These are presented in diagrams one through four.

Feedback anxiety

With regard to the feedback by group interaction it appears that high anxious students benefit markedly from direct instruction. The treatment had no effect on low anxious students in this group. In other words the more anxious a student at pretest the more likely a positive effect would be achieved in a reduction of anxiety related to receiving feedback on competence through direct instruction. Cooperative group work appears to have minimal effect on level of feedback anxiety at posttest, with posttest anxiety scores being marginally higher than at pretest.

Positive sense of control

With regard to the positive sense of control (positive cognitions) by group interaction it appears that high anxious students within the cooperative group become less anxious than equivalently high anxious students in the direct instruction group, while low anxious students become marginally more anxious. Direct instruction appears to have a marginal effect of improving a positive sense of control across the range of scores. Both instructional methods were beneficial to highly

anxious students, but for the cooperative group this was markedly so.

Negative sense of control

With regard to the negative sense of control by group interaction, it appears that for low and moderately anxious students within both groups there is little difference in effectiveness of treatment. Both reduced the anxiety of students. However, direct instruction seems to have a greater effect on reducing negative self-talk for high anxious students than cooperative grouping with self-regulation.

Computing self-concept

With regard to the computing self-concept by group interaction it appears that cooperative group work reduces anxiety levels for high anxious students (i.e., improves self concept in computing situations), but has only marginal effect on low anxious students (in this case it appears that anxiety levels increase slightly). Direct instruction appears to reduce anxiety levels slightly for low anxious students, but it appears to have no impact on high anxious students who are likely to be high anxious at posttest (i.e., have a low self concept in computing situations).

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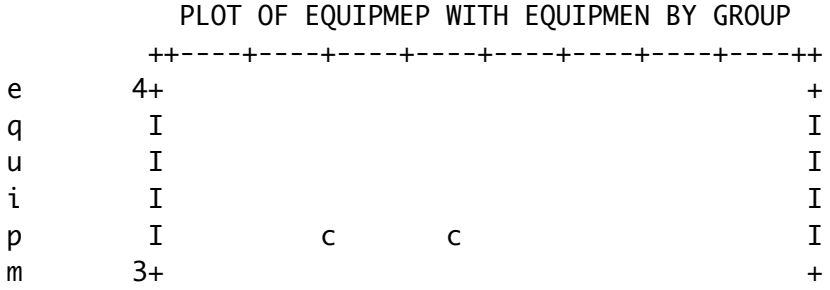
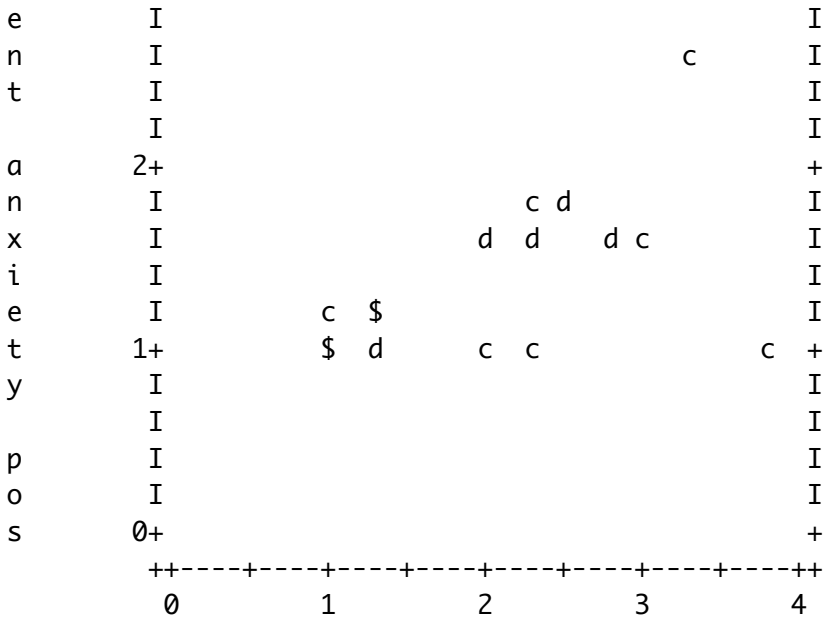
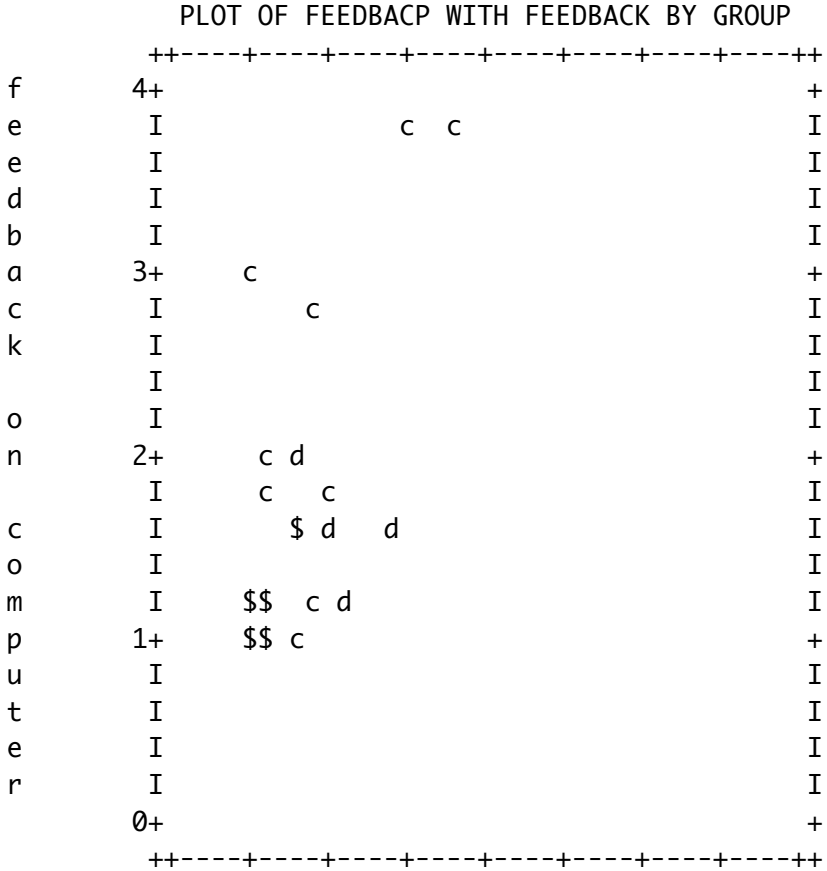
Table 1 Summary table for the significance of interaction terms derived from multiple regression analyses. Covariates: Priorcom (Prior competencies) and pretest anxiety scales.

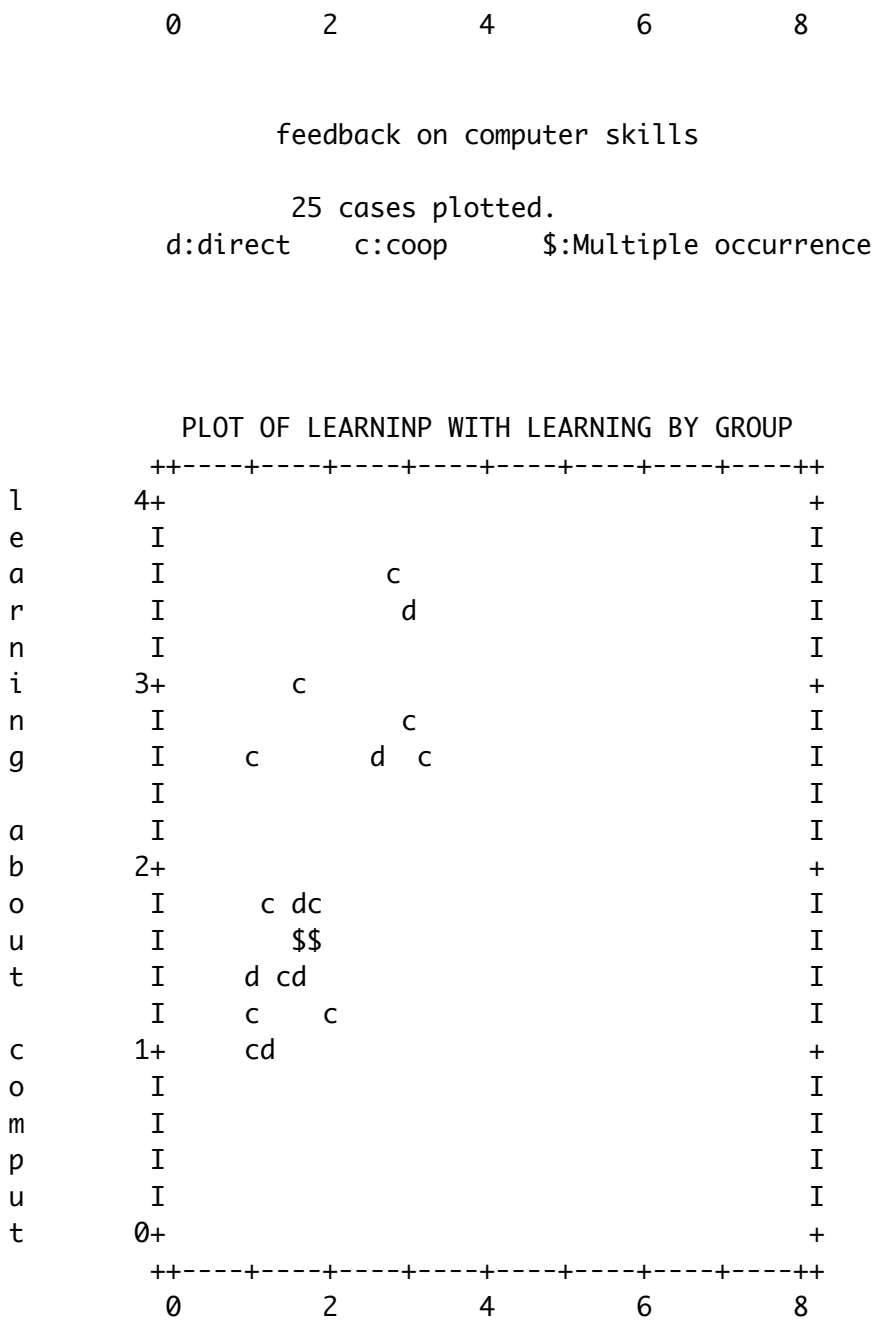
VariableInteractMultRRsqFSigFR2FchSiga termchch							
compskipcompe	.749	5.618	.409	.002	.000	1.004	.949
perforppperfore	.821	5.674	810.374	.000	.002	8.171	.684
equipmepequipe	.445	9.198	81.241	.326	.059	01.473	.239*
feedbacpfeedbace	.809	9.655	99.532	.000	.083	04.825	.040*
learninplearnine	.777	9.605	17.661	.001	.037	21.885	.185*
poscompposcome	.719	6.517	85.369	.004	.110	44.580	.045*
negcompnegcome	.862	1.743	214.471	.000	.057	84.500	.047*
posselfpposselfe	.548	1.300	42.147	.112	.120	93.456	.078*
selfconpselfcone	.526	8.277	51.921	.146	.013	3.369	.551
negselfpnegselfe	.598	8.358	52.794	.054	.031	6.985	.333
stateanpstateane	.658	7.433	93.832	.018	.034	41.216	.283
worrypworrye	.821	5.674	910.382	.000	.043	12.651	.119*
distracpdistrace	.582	7.339	52.570	.069	.002	3.070	.794
physiolpphysiole	.470	0.220	91.417	.264	.000	1.003	.956

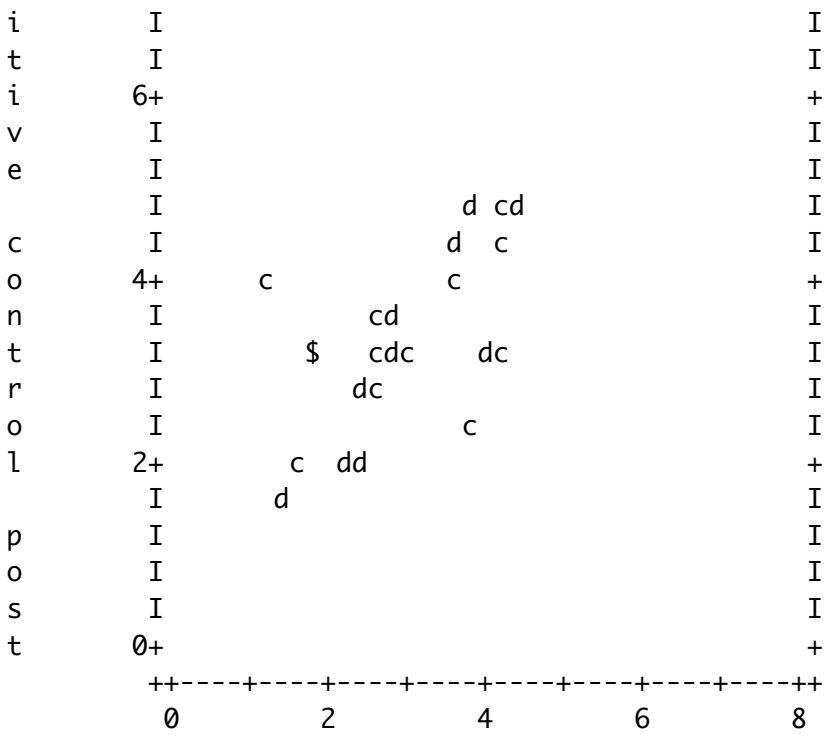
Notes:
a. Pedhazur and Schmelkin (1991, p.558) suggest that in order to minimize Type II error in aptitude-treatment-interaction studies that a relatively large alpha (e.g., .10; even .25) be used for tests of interactions. Owing to the small sample size and reduced degrees of freedom in this study we have selected .25 as a criterion probability for examining interaction effects.





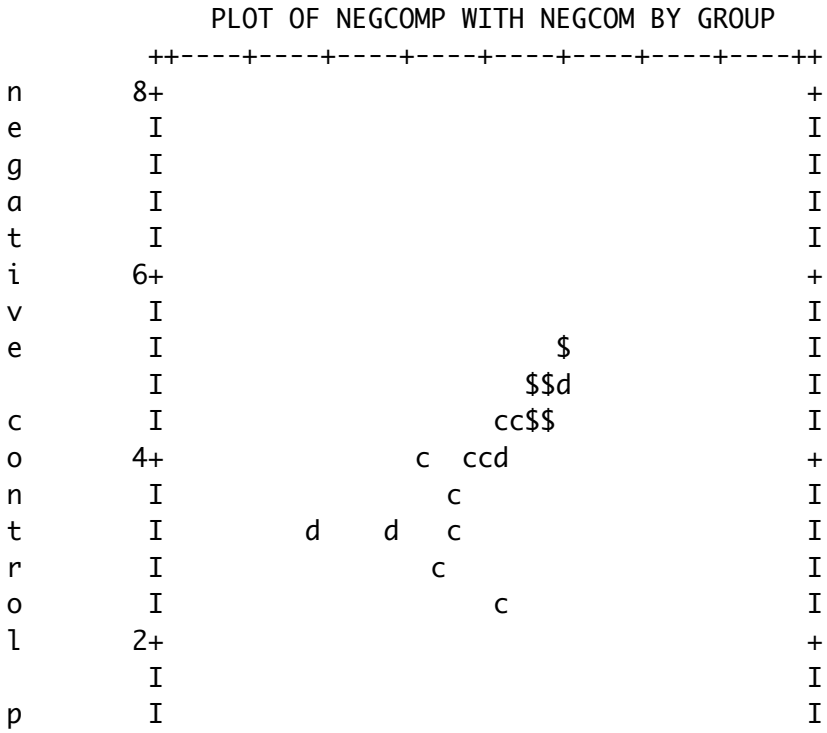


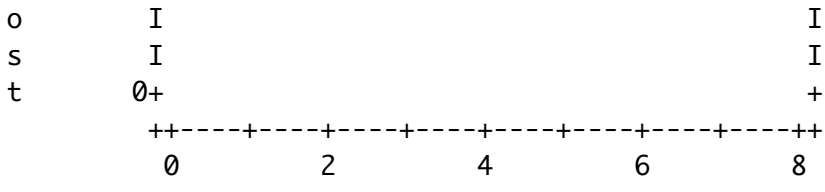




positive control

25 cases plotted.
d:direct c:coop $:Multiple occurrence

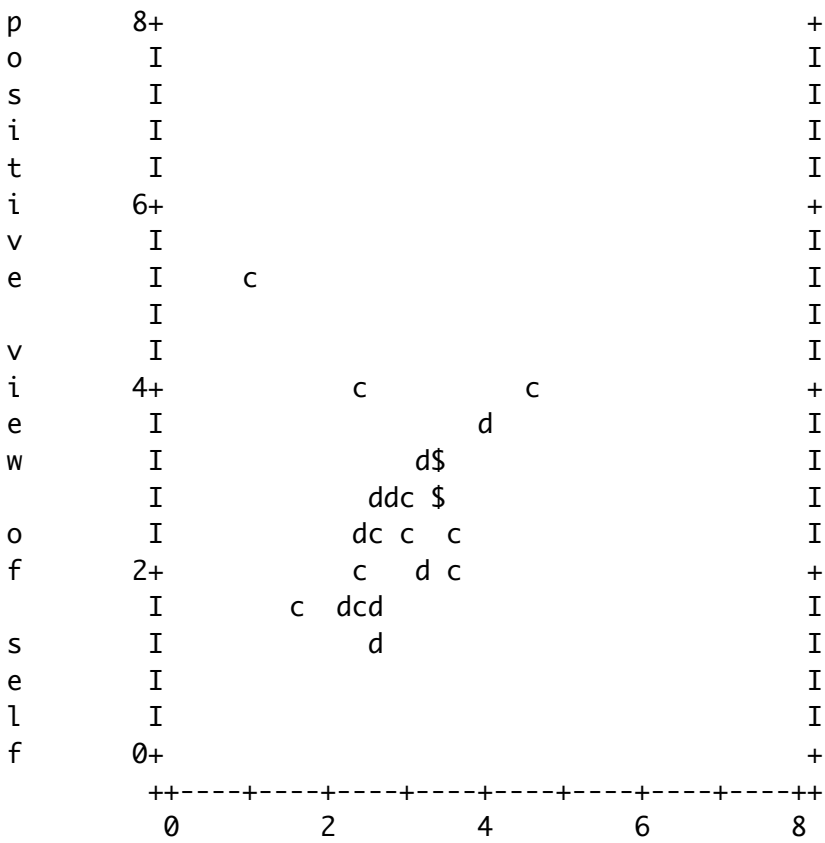




negative control

25 cases plotted.
d:direct c:coop $:Multiple occurrence

PLOT OF POSSELFP WITH POSSELF BY GROUP



positive view of self

25 cases plotted.
d:direct c:coop $:Multiple occurrence